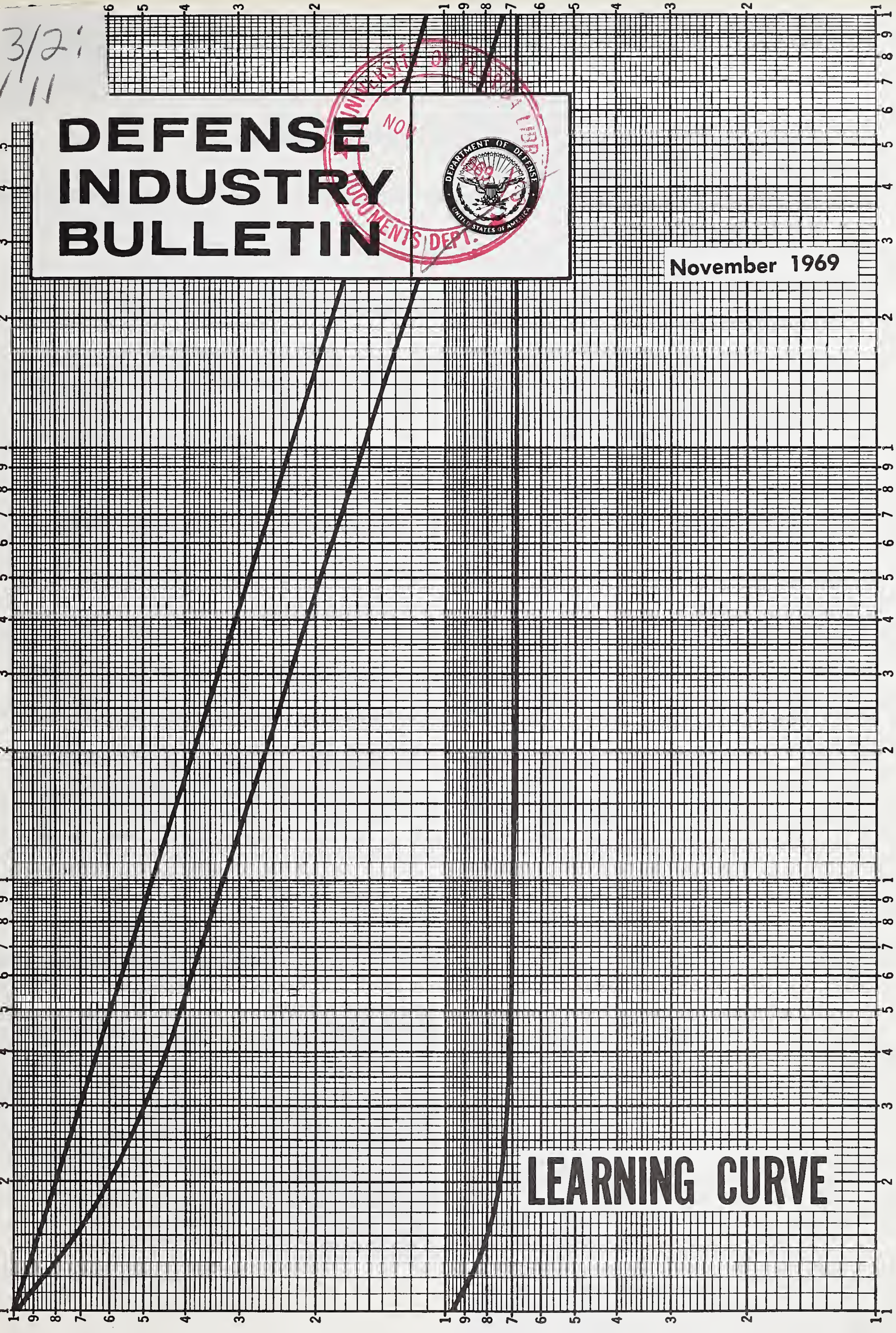
DEFENSE INDUSTRY BULLETIN

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

November 1969



LEARNING CURVE

DEFENSE INDUSTRY BULLETIN

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The *Bulletin* serves as a means of communication between the Department of Defense, its authorized agencies, defense contractors and other business interests. It provides guidance to industry concerning official DOD policies, programs and projects and seeks to stimulate thought on the part of the Defense-Industry team in solving problems allied to the defense effort.

Suggestions from industry representatives concerning possible topics for future issues are welcome and should be forwarded to the Editor at the address shown below.

The *Bulletin* is distributed free of charge to qualified representatives of industry and of the Departments of Defense, Army, Navy, and Air Force. Subscription requests should be submitted on company letterhead, must indicate the title of the requester, and be addressed to: Editor, Defense Industry Bulletin, Hq., Defense Supply Agency (DSAH-B), Alexandria, Va. 22314.

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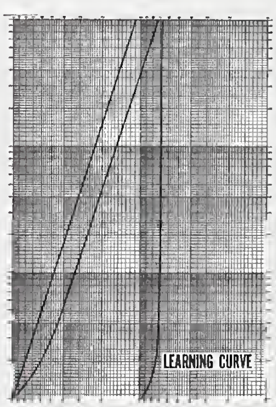

The application of "learning curves," as depicted on this month's cover, provides a manufacturer with a valuable tool in the development of cost factors associated with the production of today's complex defense hardware. A discussion of the subject appears in this issue.

Defense Department Announces Relocation of Defense Industry Bulletin

Responsibility for publishing the *Defense Industry Bulletin* has been transferred from the Office of the Assistant Secretary of Defense (Public Affairs) to the Director, Defense Supply Agency. The editorial office of the *Bulletin* is now located in Building 4, Room 4A 508, Cameron Station, Alexandria, Va.

Requests for new subscriptions, changes of address, and any other correspondence concerning the *Bulletin* should be addressed to: Editor, Defense Industry Bulletin, Defense Supply Agency (DSAH-B), Cameron Station, Alexandria, Va. 22314. Telephone number is (202) 974-7558/7559.

THE DEPUTY SECRETARY OF DEFENSE
WASHINGTON, D. C. 20301

As in the past, the Defense Department requires the continued support of American industry and labor to meet the requirements of national security. In 1965, the *Defense Industry Bulletin* was established to achieve increased public understanding of DOD policies, programs, procedures and technical developments. The need for a flow of this information is particularly important as we implement significant changes to improve our procedures over the full spectrum of military procurement.

In transferring responsibility for the *Bulletin* to the Defense Supply Agency, its mission will not change. I am confident that the *Bulletin* will continue to communicate pertinent information from all components of the Defense Department through timely news reports and authoritative articles.

David Packard

Weapons for Tomorrow, If...

Hugh E. Saunders

One "inventor" has an idea for an electric gun. Another sends in description of an invisible airplane. Yet a third suggests a means of powering a rifle with bottled gas.

Far out?

Possibly such proposals would be considered so in some circles, but not in the Future Weapons Systems Division of the U.S. Army Weapons Command (WECOM), located at Rock Island, Ill. Far from considering these ideas and suggestions as "nutty," the members of WECOM's Future Weapons Systems Division give serious consideration to each suggestion received. Although this is not their primary task, the members of the division, an element of the WECOM Reasearch and Engineering Directorate, continue to receive the "unsolicited proposals," as they dub them.

Not all of the ideas are too "far out" for serious consideration. Of the 67 unsolicited suggestions received during FY 1969, 2 are being pursued for further study under government contract.

The odds of getting an idea adopted as a formal project generally favor a industry- or university-based team of researchers rather than suggestions presented by an individual. This does not necessarily preclude acceptance of proposals from individuals; however, experience indicates that ideas which originate with a research team, will be better thought out, more comprehensive, and better aligned to the Army's requirements.

Unsolicited proposals are not limited to ideas for better rifles or invisible airplanes. During the past year, they have run the gamut from self-sharpening scissors to devices for employment in perimeter defense. They included such relatively complicated hardware proposals as air defense systems and defenses against mortars.

Nevertheless, unsolicited suggestions are an exception to the pattern which most industries follow. Most of them elect to participate in the U.S. Army Qualitative Requirements Information (QRI) Program. Under the provisions of Army Regulation 70-35, all Army agencies whose mission includes research, development, test and evaluation (RDT&E) are directed to participate in the QRI Program and designate a QRI Control Office and a QRI manager. Figure 1 lists the Army activities (one of which is the U.S. Army Weapons Command) which participate in QRI Program and includes the designation of control office and manager's name.

How Does a Company Participate in QRI?

Normally, industry participation in QRI is a four-step process. First, a company indicates an expression of interest. Most often, this is a letter simply stating the firm is interested in participating in QRI.

Second, the company executes a policy agreement for the release of QRI. This policy agreement establishes a legal basis for the release of Army QRI and the qualification of a company to participate in QRI.

Third, the firm must display that it has a research and engineering capability. Normally, this research and engineering capability is already in existence. However, when the organization's area of interest exceeds its present capability, the industry must furnish acceptable evidence of a solid and feasible intent to adequately expand the capability.

Last, the industrial organization must have a facility clearance and individual security clearances up to and including Secret. This is normally the least restrictive of the four requirements.

Once the industrial organization has met the four qualifications, the next step in the procedure is for the firm to receive a copy of the command's QRI Guide. The guide describes mission responsibilities, characteristics of some present and future weapons, and contains long-range research and engineering or development problems which require solutions.

Hugh E. Saunders serves in the Research and Engineering Directorate of the U.S. Army Weapons Command as coordinator of the Qualitative Requirements Information Program. In addition to his responsibilities regarding the QRI Program, he also handles unsolicited proposals and advanced planning briefings for industry. Mr. Saunders holds a B.S. degree in mechanical engineering from Iowa State University.

What Is QRI?

The definition of QRI is rather general. Basically, it is any information concerning current or future Army requirements for research and development.

More specifically, it may be one of two types of information. QRI may be information concerning current and future Army requirements for *applied research* to obtain knowledge, materials, techniques, or methods Alternatively, it may be information concerning current and future Army requirements for the *development* of new items, components, or materials.

The main purpose of QRI is to inform industrial organizations about Army requirement for new materiel, in order that they might most effectively conduct their voluntary developmental efforts. It has long been recognized in the Defense Department that many new ideas for weapons and other materiel are generated by industrial organizations on a voluntary basis.

Members of the Army Weapons Command welcome this interest and encourage the generation of new ideas from all sources. At the same time, they realize that there are frequent instances where costly and time-consuming voluntary efforts end in disappointment.

Disappointment can result from one of two causes. First, the originator of the idea is not aware of all aspects of the problem. Disappointment may also occur because the idea was not sufficiently compatible with all the factors which the Army Weapons Command must consider.

Review of the QRI Guide by the members of the industrial organization helps prevent this disappointment. Such a review provides the basis for developing proposals that respond to specific problems of the Army.

A proposal might be made for any one of a wide category of solutions. It might be for a lightweight low-cost propulsion system, for a lightweight artillery weapon, for the components of a hydrospring recoil mechanism, for a ballistic computer, for a silencer for a small caliber weapon system, or for a weapon system providing 10 to 1 superiority. It might be for a cupola with a complementary armament, for obturating seals for rapid fire artillery, for a device for the stabilization of vehicle-mounted weapons, for position and velocity indicators, or even for standard wire springs. It might be a solution for any one of a couple of dozen research or engineering problems.

Evaluation Process

Once a proposal is received in the headquarters of the Army Weapons Command, it is treated as a proprietary item. This treatment is in effect whether the response to the QRI is in the form of conversation, documentation, or models.

Proprietary treatment means that the material is *not* released outside the Army without prior permission of the organization submitting the material. Of course, it is conceivable that more than one industrial organization is interested in a given problem. Therefore, it follows that similar material can be received simultaneously from more than one source, or that material, similar to that which has just been submitted, is already available. This does not alter the protection that the members of WECOM will give to the material which has been submitted. It does mean that the receipt and evaluation of a proposal by WECOM does not imply a promise to pay, a recognition of novelty or originality, or any relationship which might otherwise require the Government to pay for the use of information to which it is otherwise lawfully entitled. However, the Army has no intention of using any proposal in which an individual or company has proprietary rights without proper compensation.

There is no prescribed format for the submission of proposals. However, the proposal should be made as comprehensive as possible. When a proposal that is specific to a QRI problem is submitted, a completed DD Form 1634, "Research and Development Planning Summary," should be enclosed as one page of the proposal.

When a proposal is received at WECOM headquarters, evaluation of the idea is initiated. The originator of the idea is informed of all decisions regarding possible acceptance, ideas concerning further development of the proposal, or rejection.

If the evaluation process indicates a promising solution, prompt action will be taken by WECOM to attempt to place the proposal in a funded program. Of course, the number of funded proposals is limited by the amount of funds available.

During the development of a proposal responding to an Army requirement, questions may arise about the proposal. These may be questions about technical requirements. In that case, a representative of WECOM is made available for consultation and guidance. Often during such conversations, the industry representative learns of other problems which, being relatively minor, have not yet been publicized. Then the logical thing for the industrial representative to do is to submit a proposal for the new problem which he had just discovered. This new suggestion is handled in the same way as unsolicited proposals from individuals.

Naturally, there are ways other than the QRI Program for industry to participate in WECOM's research or development programs. One of the methods is a presentation by industry before a technical audience composed of WECOM representatives. Another method is for the technical representative of an industrial firm to discuss his company's capabilities with members of WECOM. Like the unsolicited proposal, these methods involve greater risk of disappointment than formal participation by the company in the QRI Program.

Somewhat similar is the unfunded study program. The objective of this program is to assist qualified civilian organizations to conduct research and development studies which they initiate. Therefore, the civilian organization may find it advantageous to develop its study at its own expense. The Army provides a project coordinator and access, as required, to DOD data applicable to the study. In return, the results of the study are made available to the Army for future consideration. The unfunded study program requires the execution of an Unfunded Study Policy Agreement before progress can be made on each study.

Management of QRI in WECOM

WECOM has streamlined its QRI Program for the convenience of industry. Rather than have industry send proposals to each of the command's subordinates and other organizations with which it is closely allied, the QRI coordinator at WECOM acts as the single point of con-

Participating Agencies in U. S. Army Qualitative Requirements Information Program

Army Materiel Command Agencies

U.S. Army Tank-Automotive Command
Attn: AMSTA-H-L, Mr. Bird
Warren, Mich. 48090

U.S. Army Weapons Command
Attn: AMSWE-REF, Mr. Saunders
Rock Island, Ill. 61201

U.S. Army Munitions Command
Attn: AMSMU-RE-P, Mr. Watson
Dover, N.J. 07801

U.S. Army Mobility Equipment Research & Development Center
Attn: SMEFB-CO, Mr. Rhodes
Fort Belvoir, Va. 22060

U.S. Army Electronics Command
Attn: AMSEL-PP-CI-APPI, Mr. Napier
Fort Monmouth, N.J. 07703

U.S. Army Aviation Systems Command
Attn: AMSAV-R-R, Mr. Poletsky
P.O. Box 209, 12th & Spruce Sts.
St. Louis, Mo. 63166

U.S. Army Missile Command
Attn: AMSMI-RS-QRI, Mr. Hoft
Huntsville, Ala. 35809

Harry Diamond Laboratories
Attn: AMXDO-PP, Mr. Turner
Washington, D.C. 20438

Natick Laboratories
Attn: AMXRE-TP, Mr. Benedict
Natick, Mass. 01762

U.S. Army Test & Evaluation Command
Attn: AMSTE-PO-I, Mr. McGinnis
Aberdeen Proving Ground, Md. 21005

Aviation Materiel Laboratories
Attn: SAVFE-CP. Mr. Fenstermacher
Fort Eustis, Va. 23604

U.S. Army Aberdeen Research & Development Laboratories
Attn: AMXRD-XTC, Mr. Zongker
Aberdeen Proving Ground, Md. 21005

U.S. Army Edgewood Arsenal
Attn: SMUEA-POPL-L, Mr. Hart
Edgewood, Md. 21010

Fort Detrick
Attn: SMUFD-PR, Dr. Gilford
Frederick, Md. 21701

Frankford Arsenal
Attn: SMUFA-A2100-11-2, Mr. Peirce
Philadelphia, Pa. 19137

U.S. Army Materials & Mechanics Center
Attn: AMXMR Mr. Darcy
Watertown, Mass. 02172

Picatinny Arsenal
Attn: SMUPA-VCI-I, Mr. Tyler
Dover, N.J. 07801

Nuclear Defense Laboratory
Attn: AMXND-NA-N, Mr. Samos
Edgewood, Md. 21010

Watervliet Arsenal
Attn: SWEWV-RDP, Mr. Roeck
Watervliet, N.Y. 12189

U.S. Army Small Arms Systems Agency
Attn: AXXAA-XD, Maj. Medaris
Aberdeen Proving Ground, Md. 21005

U.S. Army Terrestial Sciences Center
Attn: AMXCR-TL, Mr. Floyd
Hanover, N.H. 03755

Other Army Agencies

U.S. Army Medical Research & Development Command
Attn: MEDDH-M, Mr. Beall
Washington, D.C. 20315

Office of Chief of Engineers
Chief Scientific Advisor
Attn: ENGSA, Dr. Quarles
Washington, D.C. 20315

U.S. Army Engineer Waterways Experiment Station
Office of Technical Programs and Plans, Attn: Mr. Martin
Vicksburg, Miss. 39180

Engineer Topographic Laboratories
Attn: ETL-POC, Mr. Cook
Fort Belvoir, Va. 22060

U.S. Army Security Agency
Attn: IARD-T, Mr. Sluke
Arlington Hall Station
Arlington, Va. 22212

U.S. Army Research Office
Attn: CRDARO. Mr. Davidson
Washington, D.C. 20310

Figure 1.

tact for the headquarters and WECOM subordinate mission elements.

The subordinate organizations include the Rock Island (Ill.) Arsenal and Watervliet (N.Y.) Arsenal. Rock Island Arsenal is responsible for gun mounts for artillery, tanks, and other combat vehicles, as well as small arms and aircraft weaponization. Watervliet handles all types of artillery other than mounts. Two other organizations are closely allied with WECOM: Frankford Arsenal, Pa., and the Army Tank-Automotive Command, Warren, Mich. Frankford handles fire control (aiming) devices, while the Tank-Automotive Command handles the combat vehicle portion of the WECOM mission. Each subordinate mission element submits its problems to WECOM headquarters where they are consolidated into one QRI document.

In summary, any industry, with a capability and an interest in participating in the research or the engineering programs of WECOM, should explore the avenue of approach opened up by the QRI Program. Approximately 450 firms have already done so. The first step in joining the companies already participating is relatively simple. Just address a letter, expressing an interest in the QRI Program, to the Commanding General, U.S. Army Weapons Command, Attn: AMSWE–REF, Rock Island, Ill. 61201.

New Army Computer Unit Set Up in Hawaii

The Army Computer Systems Command (USACSC), Fort Belvoir, Va., has announced the activation of the USACSC Support Group (Pacific), Fort Shafter, Hawaii, as the command's newest field organization.

Initially, the group will be responsible for the continued development and maintenance of the Standard Supply System (3S) of the U.S. Army, Pacific. The 3S is a theater depot/inventory control center supply and stock fund data processing system for supply and related financial transactions of subordinate commands, located in Hawaii, Japan, Okinawa, Vietnam and Thailand.

Commanding the new unit is Colonel Robert G. Hillman.

Predicting Production Costs with Learning Curves

Wiley F. Patton

"Once you have the first satisfactory aircraft, how good are your cost estimates?"

"Plus or minus 3 percent."

This answer, by a representative of a giant aerospace company, may surprise anyone who is unfamiliar with industrial processes. Others will recognize immediately that the question is loaded.

The key qualification is that the first satisfactory aircraft has been produced. At this point, the manufacturer should know his costs, except for rework, in intimate detail. All blueprints should be on hand, all problems with respect to networks, activities, interfaces, time and other constraints, tradeoffs, engineering, tooling, subcontracting, specifications, materials, processes, and tolerances should have been faced up to and many solved satisfactorily. In addition, the thousands of people who have been involved have experience and records which will enable them to repeat their work and incorporate improvements on existing production equipment.

Before the manufacturer has produced his first satisfactory model, he does not know production costs with the same precision as he does after experiencing the costs of a completely finished product.What is contained in this article is applicable to recurring production costs *after* the first satisfactory model has been produced. The discussion here does not, it must be made plain, apply to costs of research, development, test and evalation, or the non-recurring costs of producing the first model.

This article is about the predictability of production costs after the first satisfactory model is built. It is about learning theory and learning curve models applied to industrial learning.

After the first production model is finished, the manufacturer is in a position to know his costs of the first of all components. In the parlance of the learning curve buff, he knows his "a" values for dozens of recurring costs elements at, perhaps, dozens of work stations. Starting with his costs of producing the first model as a known point and projecting a slope computed from learning curves experienced on roughly analogous aircraft produced previously, the manufacturer can project his estimates of later recurring costs. The representative of the aerospace company says his projections are within plus or minus 3 percent accuracy.

After the first aircraft is produced, the manufacturer, almost automatically, becomes "sole source" for all aircraft of the series. Any other manufacturer would have to go through at least the initial steps of the learning process: tooling, employing and training labor, and building his first production model.

After a few score aircraft have been produced, it is common for negotiators for the Service and for the "sole source" contractor to agree, within very narrow limits, on the estimated cost of future aircraft in subsequent production runs.

On one Air Force contract, negotiators were within 1 percent or less in agreeing on the estimated costs of future aircraft long before the first production run had been completed. In the example used in this article the negotiators' agreed upon estimates were within 1 percent of the actual costs of production.

This article illustrates how a few major summaries of costs can be made to reveal considerable information by applying the family of mathematical models known as learning curves. Examination of the mathematical models and some real life data, described herein, reveals dozens of facets not adequately covered in existing literature on learning curves. Four facets are most interesting:

- The Nth unit learning curve is convex, which we will demonstrate mathematically. The demonstration will emphasize the experts' advice, "don't project learning curves too far," at least not as a single straight line. This demonstration leads logically to the suggestion that, for improved curve fitting, a series of straight lines is a useful technique.
- Precision can be added to an old tool by substituting mathematical

Wiley F. Patton is assigned as an Industrial Cost Analyst in the Directorate of Production and Programming, Office of the Deputy Chief of Staff, Research and Development, Headquarters, U.S. Air Force. He previously served as Chief Statistician with the Air Force Systems Command. Mr. Patton holds a B.S. degree in electrical engineering from the University of Tennessee.

values of cumulative average costs and the Nth unit costs for visual reading of the values from log-log charts.

- How to use mathematical tables to move from cumulative average values to Nth unit values is demonstrated, using real-world data.
- Projection of functional dollar costs separately is proposed. (Actual historical dollar costs are already influenced by inflation; thus, the projection can be made with probable accuracy unless the *rate* of inflation changes.)

The following discussion of these applications of learning curves is admittedly incomplete. Indeed, a variety of issues are raised by learning theory, but only the most interesting can find space to be mentioned here.

The words "learning curve" are widely used, have a variety of meanings, and are frequently used more or less interchangeably with "progress curve" and "experience curve."

"Learning curve" is defined here as a line on a graph (logarithmic or arithmetic). When defined in this way, it expresses the idea that the time to do the job will decrease, hopefully, each time the job is repeated. The amount of decrease will be less with each successive unit. By extension, the name "learning curve" is also applied to the data on which the line is based.

The psychologist, in his own field, uses the term "learning curve" to describe a basic human characteristic. In doing a job, an individual reaches successive "plateaus" of learning where no improvement in his skill can be detected for a time. There is no advance warning when the individual is able to move to the next higher plateau in his skill. No mathematical models show what to expect from an individual. One never knows when the highest plateau has been reached. Consider the blind poet Milton; the deaf musician Beethoven; the once tongue-tied orator Demosthenes; the once crippled boy, later holder of the world record for the mile run, Glenn Cunningham.

In the industrial field, however, where hundreds or thousands of individuals are involved in the learning process together, the law of large numbers applies. Statisticians can develop mathematical models to describe the learning process of a large number of workers, or of the enterprise.

T. P. Wright in "Factors Affecting the Costs of Airplanes," *Journal of Aeronautical Sciences*, February 1936, published the first authoritative paper on the subject. He pointed out that the "cumulative average cost" of direct manufacturing man hours in producing airframes tended to be a straight line when plotted on log-log paper and to have a slope which tended to be 80 percent. His mathematical formula or model $y = aX^b$ (where X is the cumulative average cost) also defines the fixed convexity of the Nth unit curve.

J.R. Crawford, in "Asymptotic Progress Curve Tables," published by the Lockheed Aircraft Corp. in 1945, first produced "progress curve" data based on the idea that the Nth unit cost of airframes was a straight line on log-log paper. The change in the underlying mathematical model was made to get away from the "bundlesome" exponential formulas needed to project costs of future units under the Wright formula. His formula is $y = ax^b$ (where x is the Nth unit cost).

To the lasting confusion of all, both definitions are accepted as proper without even referring to the Crawford formula as the "modified" definition. Figure 1 shows graphically the difference between the two 80-percent learning curves and a test for *parallelism*. (The Crawford cumulative average curve which arches from the starting point above the straight line is omitted.)

Harold Asher in "Cost Quantity Relationships in the Air Frame Industry," Rand Corp. R-291, July 1, 1956, published an exhaustive review of the literature extant on the subject through 1955. He pointed out that the higher the starting point on the progress curve for an airframe, the steeper the slope tends to be. He elaborated on the implications of the difference in progress curve slopes between various production jobs. He was well aware that there are differences in progress curve slopes of direct manufacturing man hours among various production jobs incorporated in one figure, and that the Nth unit curve for labor was convex.

Note that the subject had grown even more complex. In addition to the problem of "convexity," it had been found that, in general, the higher the starting point of the curve, the steeper the slope tended to be.

Other, lesser known studies attempted to establish formulas for learning curves involving variations from a straight line on log-log paper.

It is worth digressing a moment to note that log-log paper is widely used for learning curve presentation and is unquestionably a useful tool. On the

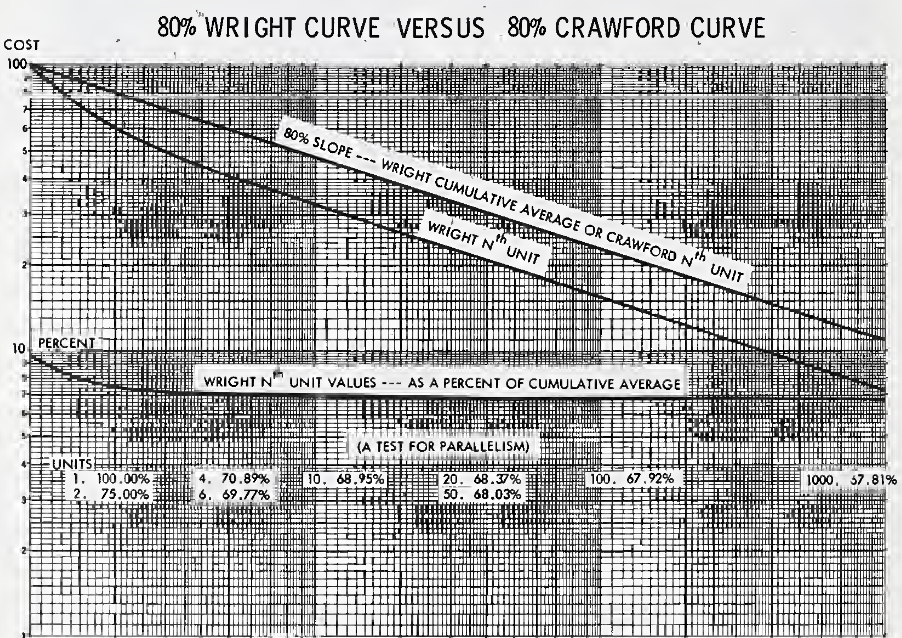

Figure 1.

Progress Curves

N	76.0 CUM TOTAL	76.0 C.A.	76.0 UNIT	77.0 CUM TOTAL	77.0 C.A.	77.0 UNIT	78.0 CUM TOTAL	78.0 C.A.	PAGE 241 UNIT
1	1.00000000	1.00000000	1.00000000	1.00000000	1.00000000	1.00000000	1.00000000	1.00000000	1.00000000
2	1.75999999	0.88000000	0.76000000	1.77000000	0.88500000	0.77000000	1.77999999	0.88999999	0.77999999
3	2.40728271	0.80242757	0.64728272	2.43083349	0.81027783	0.66083351	2.45448762	0.81816254	0.67448763
4	2.98488271	0.74622068	0.57759999	3.02373350	0.75593337	0.59289999	3.06288761	0.76572190	0.60839999
5	3.51364166	0.70272833	0.52875894	3.56878760	0.71375752	0.54505412	3.62451908	0.72490381	0.56163146
6	4.00557649	0.66759609	0.49193487	4.07762939	0.67960490	0.50884180	4.15061945	0.69176991	0.52610035
7	4.46838516	0.63834073	0.46280863	4.55773765	0.65110538	0.48010825	4.64843816	0.66406260	0.49781875
8	4.90736115	0.61342014	0.43897600	5.01427066	0.62678383	0.45653300	5.12299019	0.64037377	0.47455200
9	5.32633609	0.59181511	0.41897491	5.45097160	0.60566351	0.43670092	5.57792372	0.61976930	0.45493356
10	5.72819287	0.57281929	0.40185679	5.87066323	0.58706632	0.41969167	6.01599628	0.60159963	0.43807253

Figure 2.

other hand, mathematical models are even more useful and can reinforce one's appreciation of both the utility and shortcomings of log-log paper.

Despite the confusion and complications already described, a young statistician, industrial engineer, or capable clerk can use an easily verified technique to find and interpret learning curves. The technique is not dependent on reading values from log-log graph paper. It uses ready-made progress curve tables based on mathematical models (see Figure 2.)[1]

The following case study illustration uses actual figures for all functional costs, which have been "adjusted" by a common factor. The original proportional relationships are undisturbed (see Figure 3). The clerical analysis recommended herein will produce a very respectable amount of useful information. The progress curve tables used in this illustration are based on the concept that the Nth unit values forms a straight line (see Figure 1).

Using the Learning Curve Tables

In predicting costs or in negotiating a price for a follow-on contract, it is useful for negotiators to know the recurring costs of production, and progress slopes for the several functional factors of production, *e.g.*, engineering, tooling, manufacturing. In our example we have chosen to work with costs incurred after production of 6 units and 133 units. At the time of negotiation, it is also necessary to evaluate the need for additional "non-recurring costs."

By extracting information from the published tables and from known cost information, and by making simple calculations, the young statistician or analyst can construct two tables of learning experience for the negotiators. The first table relates cumulative *total* costs to appropriate learning curves, and is the basis for the second table. The sec-

[1] *For an example of tables of learning curves, see Fowlkes, Tommie F.*, "Aircraft Cost Curves, Derivation Analysis Projection," *Ft. Worth: General Dynamics Corp., 1963.*

Reported and Derived Cost Information

(Recurring Costs as Reported—Dollar Figures in Thousands)

	CUMULATIVE COSTS 6 Units	CUMULATIVE COSTS 133 Units	CUMULATIVE AVERAGE COSTS 6 Units	CUMULATIVE AVERAGE COSTS 133 Units	133RD UNIT COST (Derived)
Engineering	$ 3,851	$ 44,491	$ 641.8	$ 334.5	$ 257.6
Tooling	2,347	31,567	391.2	237.3	195.3
Quality Control	2,256	16,041	376.0	120.6	72.1
Manufacturing	47,625	299,646	7,937.5	2,253.0	1,248.2
Raw Material	9,161	112,023	1,526.8	842.3	666.3
Other Direct Costs	5,764	20,575	960.7	154.7	65.0
Equipment	3,342	72,144	557.0	542.4	539.7
Other	444	3,482	74.0	26.2	16.6
Sub total	$74,790	$599,969	$12,465.0	$4,511.0	$3,060.8*
Deferred	(3,434)	(3,434)	(572.3)	(25.8)	--
Total	$71,356	$596,535	$11,892.7	$4,485.2	$2,937.8

*The cost of the 133rd unit ($3,060.8) based on the sum of the individual cost element projections is more reliable than the projection based on the combination of cost elements ($2,937.8).

Figure 3.

Learning Curve Data

Cumulative Total Costs

Col 1	Col 2	Col 3	Col 4 (2÷3)
Percent Slope or Cost Category	Cumulative Total Costs Table Values or $ Values 6 Units	133 Units	Ratio 6 Units to 133 Units
Other Direct Cost	$ 5,764,000	$ 20,575,000	28.01*
67	3.39872169	16.87963462	20.80
68	3.46249077	18.05397177	19.20
69	3.52716672	19.30737424	18.28
70	3.59275299	20.64442110	17.40
71	3.65925294	22.06990361	16.60
Mfg. Labor	$47,625,000	$299,646,000	15.89*
72	3.72667000	23.58883405	15.83
73	3.79500756	25.20645213	15.05
74	3.86426890	26.92823339	14.35
Quality Control	$ 2,256,000	$ 16,041,000	14.06*
75	3.33445745	28.75989652	13.70
76	4.00557649	30.70741153	13.05
Other	$ 444,000	$ 3,482,000	12.75*
77	4.07762939	32.77700806	12.45
Total	$71,356,000	$596,535,000	11.96*
78	4.15061945	34.97518301	11.88
79	4.22454983	37.30871010	11.30
80	4.29942399	39.78464746	10.80
81	4.37524503	42.41034651	10.30
82	4.45201629	45.19346237	9.75
83	4.52974099	48.14196110	9.40
84	4.60842234	51.26413012	8.97
Engineering	$ 3,851,000	$ 44,491,000	8.66*
85	4.68806350	54.56858778	8.57
86	4.76866770	58.06429243	8.21
Raw Material	$ 9,161,000	$112,023,000	8.18*
87	4.85023808	61.76055241	7.86
88	4.93277782	65.66703701	7.50
Tooling	$ 2,347,000	$ 31,567,000	7.43*
89	5.01629013	69.79378605	7.20
90	5.10077804	74.15122032	6.88
91	5.18624479	78.75015163	6.60
92	5.27269340	83.60179520	6.30
93	5.36012703	88.71777725	6.05
94	5.44854873	94.11015224	5.78
95	5.53796154	99.79140854	5.54
96	5.62836862	105.77448177	5.32
97	5.71977299	112.07276821	5.12
98	5.81217760	118.70013332	4.91
99	5.90558565	125.67092896	4.80
Equipment	$ 3,342,000	$ 72,144,000	4.63*

*Calculated percentage, numerically ordered.

Figure 4.

ond table relates cumulative *average* recurring costs to the learning curve to find the cost of some subsequent unit, the 133rd unit in our example. Examples of the two tables are Figures 4 and 5, respectively.

The analyst must first post from the published learning curve tables the values for cumulative *total* costs for 6 units and 133 units. (This matches the structure for functional costs; the dollar figures are reported as cumulative total costs in Figure 3.) The analyst must calculate the ratio of the cumulative total cost of 6 units (column 2, Figure 4) to 133 units (column 3) for all table values and post these in column 4. He must also figure the same ratio for the functional cost summaries. Then he distributes the ratios for the functional cost data in numerical order, between the next highest and next lowest ratio of the table ratios he previously calculated. For example, manufacturing labor falls between the rows representing 71-percent slope and 72-percent slope, its position being determined by ratios in column 4. Quality control costs fit somewhere between the 74-percent and 75-percent slopes. By this simple process, the analyst has placed all functional costs on their approximate cumulative total learning curves.

Note that an error in posting a "table value" in the series would distort the expected ratio and could be spotted immediately by the professional supervisor.

Unit Cost Table

The next step is to calculate the cost of the 133rd unit, based on information available and developed previously. This step will produce the table in Figure 5.

From the progress curve tables the analyst posts the cumulative *average* cost of 133 units and the *unit cost* of the 133rd unit for each experience curve. He then calculates the ratio of the unit cost to the cumulative average cost to produce column 8, Figure 5. (Calculations of the ratios may be reversed, provided the functional cost data is treated the same way as the table values.)

The *cumulative* dollar cost of the 133 units must be divided by 133 to obtain the cumulative *average* cost from the data furnished in Figure 3. These cumulative average costs for each functional category must be interspersed at exactly the same points as determined earlier for cumulative total costs, Figure 4. Based on interpolation from column 4 of the cumulative total costs table, the Nth unit cost ratio may be determined for posting in column 8 of the cumulative average costs table, Figure 5.

Next, the ratio for each functional cost is multiplied by its cumulative average cost to find the cost of the 133rd unit, the Nth unit, for posting in column 7, Figure 5.

Note on Figure 5 that manufacturing labor costs for the 133rd unit are 55.4 percent of the cumulative average cost; quality control costs for the 133rd unit are 59.75 percent of the cumulative average cost.

Professional Interpretation Required

Note that the sum of the functional cost, all assumed to be straight lines on log-log paper, is greater for the 133rd unit than the projection of the total cost, calculated in the same manner; $3,060.8 thousand versus $2,937.8 thousand. Thus, the nonlinearity of a summary cost curve made up of curves of different slopes is apparent. This demonstrates why one does not project a learning curve too far.

Even the sum of the functional costs ($3,060.8 thousand) will be lower than the actual cost of the 133rd unit, because some of the functional cost curves are also not linear, a factor not considered here. For example, with respect to direct manufacturing labor costs for the aircraft selected as the example, a straight line, as calculated, overstates the cost of items 2 through at least the 50th unit. A straight line understates the cost of item 1 and beyond about item 70 to the end of the series. Considerably less is known about the shape of the other functional cost curves.

With periodic summaries of cumulative costs for 1 unit, 6 units, 25 units, 133 units, etc., it would be possible to calculate a series of slopes between these points to approximate

Learning Curve Data

Cumulative Average Cost & Nth Unit Cost

Col 5 Percent Slope or Cost Category	Col 6 Cumulative Average Recurring Cost 133 Units	Col 7 133rd Unit Recurring Cost	Col 8 Percent 133 Unit Cost of Cumulative Average Cost
Other Direct Costs	$ 154,000 [a]	$ 65,000 [c]	42% [i]
67	.12691455	.05928005	46.709
68	.13574415	.06581169	48.482
69	.14516822	.07295159	50.253
70	.15522121	.08074635	52.020
71	.16593912	.08924536	53.781
Mfg. Labor	$2,253,000 [a]	$1,248,200 [c]	55.4% [i]
72	.17735965	.09850096	55.537
73	.18952219	.10856858	57.285
74	.20246792	.11950686	59.025
Quality Control	$ 120,600 [a]	$ 72,100 [c]	59.75% [i]
75	.21623982	.13137778	60.75
76	.23088279	.14424681	62.476
Other	$ 26,200 [a]	$ 16,600 [c]	63.3% [i]
77	.24644367	.15818307	64.187
Total Costs*	$4,485,200 [a]	$2,937,800 [c]	65.5% [i]
78	.26297130	.17325945	65.885
79	.28051662	.18955280	67.573
80	.29913268	.20714406	69.248
81	.31887478	.22611842	70.911
82	.33980047	.24656554	72.562
83	.36196963	.26857963	74.199
84	.38544459	.29225972	75.824
Engineering	$ 334,500 [a]	$ 257,600 [c]	77.0% [i]
85	.41029013	.31770978	77.435
86	.43657362	.34503891	79.033
Raw Material	$ 842,300 [a]	$ 666,000 [c]	79.1% [i]
87	.46436505	.37436155	80.168
88	.49373712	.40579769	82.189
Tooling	$ 237,300 [a]	$ 195,300 [c]	82.3% [i]
89	.53476531	.43947300	83.741
90	.55752797	.47551911	85.291
91	.59210640	.51407377	86.821
92	.62858492	.55528110	88.338
93	.66705096	.59929175	89.842
94	.70759513	.64626318	91.332
95	.75031134	.69635988	92.809
96	.79529686	.74975356	94.273
97	.84265239	.80662346	95.724
98	.89248221	.86715650	97.162
99	.94489420	.93154763	98.588
Equipment	$ 542,400 [a]	$ 539,700 [c]	99.5% [i]

*The sum of the elements is $3,060,800 and is more accurate than the $2,937,800 shown.
[a] Average cost.
[c] Calculated valve.
[i] Interpolated value.

Figure 5.

the true shapes of the Nth unit cost curves. In this way, if one knows the starting point and additional points on either the cumulative average or Nth unit curves, human endeavor can be compared with existing mathematical models with closer fit of the data.

Note that the computations of the recurring cost elements of the 133rd unit are based essentially on interpolations within the published logarithmic tables. Note also that the range of values between interpolation points are small, except at the extremes of the published tables; at slopes greater than 67 percent, where "other direct costs" occur; and at slopes smaller than 99 percent, where "equipment" costs occur. Errors in interpolation cannot exceed a fraction of 1 percent of the total cost.

One peculiar feature of the technique might be overlooked. Historical dollar figures are shown and they already contain an inflationary factor. (The generally accepted rate is 3 percent a year.) Further inflation will not affect the projection of functional cost data, unless the *rate* of inflation changes.

The demonstrated non-linearity of the "total costs" learning curve warns against projecting even the functional costs curves too far into the future, because they also are almost certainly not linear. A series of straight lines to approximate actual experience would make the existing mathematical models far more useful in projecting later costs.

Learning Curve on Log-Log Paper

The data calculated for direct manufacturing labor costs are shown graphically on log-log paper (Figure 6).

It is not necessary to read values from the chart. All needed values have been calculated by using published experience curve tables and raw data. Note that the dollar values used as input could relate to any item of hardware without affecting the methodology.

The computations illustrated in this article can be made without a thorough understanding of statistical, psychological, mathematical, or economic theory, or industrial engineering. The methodology has been shown in considerable detail so that the steps may be easily duplicated for various quantities to fit the raw data available. The method is not limited to any industry or any particular group of costs.

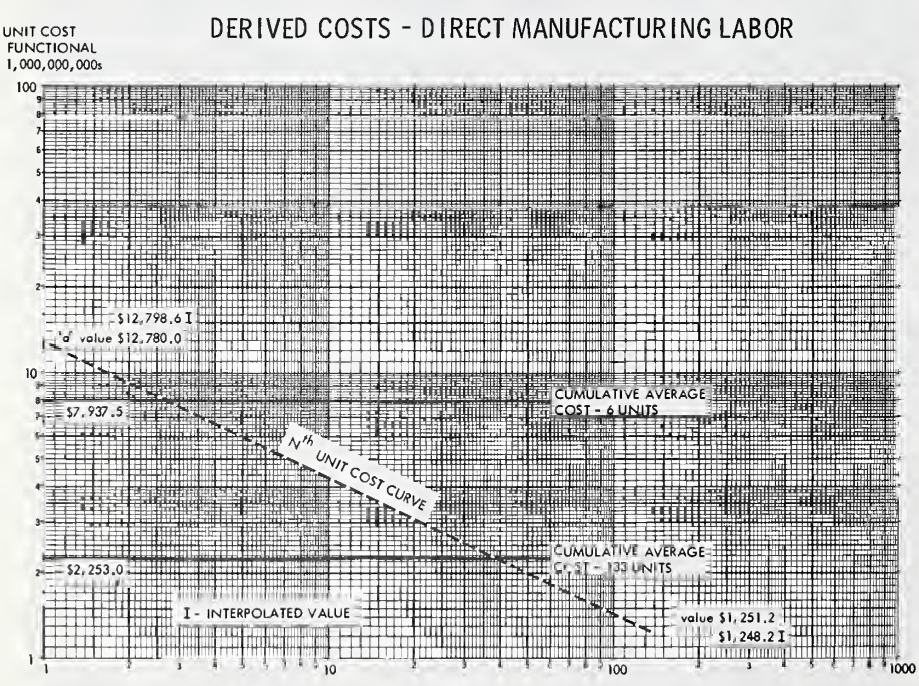

Figure 6.

DOD Expands Voice, Data Communications Systems

Three automatic communication systems serving the Defense Department and the Military Services are being expanded to meet increasing needs.

The first, the Automatic Voice Network (AUTOVON), has activated four new switching centers in Europe, and one in the Panama Canal Zone, to include these areas in DOD's worldwide AUTOVON system. The new centers, at Hillingdon, England; Langerkopf and Feldberg, Germany; Naples, Italy; and Corozal, Canal Zone, are part of an AUTOVON network that will eventually link more than one million telephones, teletypewriters and high-speed data sets at 2,000 military bases. The system is expected to be fully operational in 1971.

The second expansion is of the DOD's Automatic Digital Network (AUTODIN), which is receiving 17 overseas installations of the Digital Subscriber Terminal Equipment (DSTE). The terminals, customized to meet the needs of the individual units, will eventually eliminate the present system of separate teletype and data card terminal equipment. Present industrial contracts for this equipment will be terminated as the DSTE installations are completed, totalling 1,046 processing terminals around the world.

The third system is the Air Force Automatic Digital Weather Switch (AWDS) installation at Carswell AFB, Tex., part of the Automatic Weather Network (AWN). With activation at the end of the year, the new AWDS will join switches in Japan and England to provide Air Force bases around the world with access to the services of AWN. AWN is a computer system for collecting, editing and delivering weather data. Global weather conditions are relayed via AWN to the Air Force Global Weather Central, Offut AFB, Neb., where they are refined into atmospheric analyses and forecasts to be distributed back through AWN to worldwide users.

FROM THE SPEAKERS ROSTRUM

Transportation: Consider the Total Cost Equation

General F. J. Chesarek, USA

Address by General F. J. Chesarek, USA, Commanding General, Army Materiel Command to the 24th Annual Transportation and Logistics Forum, National Defense Transportation Association, Atlanta, Ga., Sept. 23, 1969.

In July, when Neil Armstrong and Buzz Aldrin were speeding back to Earth at several thousand miles an hour from their historic walk on the moon, the United Press International reported on a 72–year old man who was making his third cross-country trip in a red wagon pulled by a 14-year old mule. Taking 10 months to make the journey across the United States—from Iron City, down here in southwestern Georgia, to Garden Grove, Calif.—and needing 22 pairs of mule shoes for the journey, this earth traveler named Moe Mobley said; "I'm in no hurry to get nowheres. I'll get there when I do." He also commented that "folks who travel on them highways is in a big hurry to get somewhere and they ain't nowhere when they get there."

Unfortunately, the Army is usually in a big hurry to get somewhere; and when we get there, we are definitely someplace, even though we may not be particularly thrilled at the environment in which we find ourselves.

I remind you of the mule story, not because the mule is the Army's mascot and old friend of a bygone era, but to return you to a more earthy mental posture after National Aeronautic and Space Administration's brilliant moon adventure.

A further spur to our imaginations along the theme of this year's forum, "Transportation—New Horizons", was contained in a lead article in the September issue of the *National Geographic* entitled "The Coming Revolution in Transportation", which I'm sure you have all read with proud and anticipatory approval. It speaks of hovercraft, automated electric automobiles, the civilian version of the C–5A aircraft, automated airports of tomorrow, high speed trains, robotized shuttles, tube trains suspended and propelled by compressed air, and busses and houses that fly, among other marvels of human imagination.

One major ingredient was missing in the article—the mundane issue that caused Moe Mobley to use a mule on his trip west—and that is cost. This is the theme on which I will concentrate, because cost has become the dominant consideration in defense management.

Today we are facing a national crisis. This one is different in that the attack is internal, with the credibility and capability of Defense Department officials at all levels to manage their affairs being challenged on all fronts.

The challengers have a wide array of purpose. There are those who are seeking to change our foreign policy and international commitments by attacking the defense apparatus which supports existing foreign policy. Another group seeks to change our national priorities by reducing the resources allotted for defense and applying these resources to a wide assortment of domestic needs.

These first two groups apply what might be described as the Rubber Russian concept in support of their positions. In applying this concept, one stretches or compresses the threat analysis, usually by focusing on enemy intentions rather than on enemy capabilities. In this instance, the dangers posed by world instability are played down, indicating that the continuation of a strong defense force is unnecessary. At the same time, these groups say that we in the defense establishment apply the concept in reverse where, by appropriate stretching, we indicate that our current capability is insufficient to meet the threat posed.

There is a third group of critics—those who are seriously concerned over our managerial procedures and the need to eliminate waste in the defense appropriation of over $75 billion.

This third group can be further broken down into two subgroups: First, those who apply the principle of well-balanced inadequacy. This is best described by the old maxim: "A chain is only as strong as its weakest link." Any analyst well tuned to the principle of well balanced inadequacy would recognize that the solution is to weaken all other links, thereby bringing all parts of the chain into inadequate balance. The other part of this third group of critics are those who are knowledgeable of the profession of management and who have been seeking out legitimate soft spots.

As the Army Materiel Command spent about $14 billion of the defense budget last year, needless to say we take very seriously the views of our informed critics.

Let me start with the flat statement that we can do a better job in managing the resources entrusted to us. I know of no industry, governing body, or any other institution that has reached an unchallenged summit of managerial excellence.

Part of the Army's current requirements is for the transport of people and things. In FY 1969, the Army spent about $2 billion for this purpose and estimates that it will spend approximately the same amount in the current fiscal year.

This, however, is just the pure transportation cost and, therefore, is an inaccurate measure of what the movement of people and things really costs, because closely associated are the costs of packaging, preservation, in-transit losses, loading and unloading, and other associated elements. All these things should be grouped under the heading "cost of transportation."

Your industry has not been totally blind to these associated costs. The containerization program is a noteworthy advance, and the degree to which containerization has thus far been applied is only step one in its evolution. But I believe that if true progress within rational financial constraints is to be made, the transportation industry should take the lead in breaking out all aspects of the cost of transportation and directing funds and talent to devise ways and means to drive down this total cost.

Containerization

Let's look first at containerization, which does address several elements of this total cost equation. In order to do so, I should mention briefly the present process of supporting our forces in Vietnam. Most materiel is packaged and shipped from depots in the United States to a port. At the port, packages are segregated by destination and decisions made as to what goes by containers or in bulkshipments. Containers are then stuffed and loaded aboard ship. At the far end of the pipeline, the materiel is unloaded from the container and binned or stored in a depot in Vietnam from whence it is issued as required.

In the early stages of the war, we had no offshore depots, so the ports became clogged, material was stacked up wherever there was room, and the weather played havoc, as did pilferage and just plain loss.

How much better it would have been had we designed containers as segments of a depot—all binning, marking, and documentation at the depot in the United States where time and talent were available. Then, we could have moved the containers by rail piggyback or on wheels to the port and, thence, to Vietnam where they would be moved unopened to a depot site. Fifty, one hundred, or any required number could be arrayed in an appropriate geometric pattern. The supply people would operate out of the containers—no loss, no missing documentation, no weather problems, no multiple handling. Then, as onshore construction proceeded, the contents of the containers could be moved by their built-in sections into the fixed depots. By that time, sufficient retrograde cargo would have been developed to fill the containers and send them home loaded. While we cannot prove it yet, I am certain that the costs of immobilizing several hundred or even thousands of containers for up to six months, or even longer, would be a mere fraction of the cost of doing it the hard way.

We are making a detailed cost analysis of this approach and will call on this Association for assistance as required.

While on the subject of containerization, we have really not scratched the surface of innovative uses for these interesting boxes—for prepackaged fire control centers, command posts, mobile shops, and communications centers. Our heavy-lift helicopters should be designed to carry them from shipboard to actual points of use. We are also looking at a concept of thru-put supply—from our depots or factories direct to the field units.

Packaging, Marking, Documentation

Now let me turn to another costly aspect of the total transportation bill —packaging, marking, and documentation. Here again, while advances have been made, I think we are still operating a feudal system, because there is no integrative mechanism which tells us what is best for the transporters, receivers and shippers.

The Defense Supply Agency is experimenting with new techniques using the Fairbanks Morse Corp. inmotion weighing and cubing machine, called the Caprocon. The depot at Ogden, Utah, has had the Caprocon complex in operation for two years now. Besides automatically giving the weight, cube and piece data, it assists in the preparation of gummed labels which are used in the preparation of bills of lading.

More importantly, the future plans call for the mechanization of their freight terminal. This will give them a highly automated/mechanized packing, containerizing and handling facility for both freight and parcel post. Caprocon assisted in the operational concepts and preliminary design of that facility.

Also, plans are being developed for a system to provide computer-prepared continuation sheets for government bills of lading. The system would use the address file and freight data file now in the computer memory along with specific weight, cube and piece data, provided by the Caprocon, for each shipment unit. In addition to the preparation of the government bills of lading, the computer will be used to route, locate and manage material in process in the mechanized freight terminal. Also planned is the production of shipping address labels or stencils for automatic application on containers as they pass through the Caprocon.

In packaging, we need much new thought and imagination. I have not seen much which minimizes cost while providing the requisite protection. It is becoming a self-contained industry whose motives, I'm sure, are good but which does not, in my opinion, give appropriate consideration to cost.

Materials Handling Equipment

Next, a comment on materials handling equipment, or lack thereof. We should be devising or selecting handling systems that are best suited to our military environment—a system specifically designed to complement the site, climate, labor, connecting transportation systems, and other critical features of an area of operations. What this means is that what works in Europe may not in Vietnam, and what is good for peacetime purposes may be quite unsuited for military contingencies.

In advanced countries, distribution of goods is the third largest cost of doing business, topped only by the costs of labor and materials. It offers the greatest opportunity for using new efficiencies to reduce cost. One might say that the first great revolution in American transportation took place years ago when the rails of the Union Pacific and the Central Pacific met and welded a nation together. The second revolution was the development of truck transport; the third, movement of cargo by air.

Today we have the capability of initiating a fourth revolution based on managerial potential: the welding together of the capabilities of our rail-

ways, highways, airways, waterways, and the associated elements which go to make up the total cost of transportation into a great, unified, cost-effective transportation system capable of meeting the staggering demands of the future. We commonly refer to this as intermodal transportation—an area fertile with opportunities for savings for customers as well as suppliers from through rates and single carrier responsibility. If we had a good, dependable transportation service, we could reduce inventories and move into the big tent in cost reduction.

Paradoxically, transportation, as viewed by a major customer, is in many respects an industry divided against itself. It consists of many separate interest groups—shippers, carriers, suppliers, investors—which form interacting alliances against each other to resolve specific issues that affect the industry as a whole. As I mentioned previously, the situation is further compounded when we look at the accessory industries of packaging, materials handling, etc. I do not know whether this great Association has attempted to broaden its spectrum by joining with the associations supporting these other industries. I hope you do so, and quickly. There is a lot of gold to be mined in developing strong integrative links of all industries which contribute to the total cost of transportation.

All of this is a far cry from the exciting future held out for space exploration and the visionary adventures which such exploration conjures in our minds. What I have been talking about is what we live with day to day and, as the Army is obviously a good customer of your industry, it is our duty to challenge you to provide us a better service at less cost, just as we are doing with industries associated with research, development, and production.

The Army is pressing for economies in every aspect of logistic endeavor. Because your share of this pie is so substantial, we must look to you for help. The Army would be very pleased to establish a joint panel with this Association to explore further the potentials I have touched upon and any others you may have in mind.

Does the Air Force Really Want Value Engineering?

Address by Lt. Gen. H. E. Goldsworthy, USAF, Dep. Chief of Staff (Systems and Logistics), Hq., U.S. Air Force, at the Air Force Systems Command/Industry Conference, Colorado Springs, Colo., Sept. 29. 1969.

I welcome the opportunity to participate at this Air Force Systems Command/Industry Value Engineering Conference. The theme, "Value Engineering: Responsibility of Management," is, I believe, particularly timely. Defense Department managers at all levels, and their industry counterparts, are under considerable pressure to find more effective and less costly ways to adequately provide for this country's defense. It is quite clear that the challenges to management, both in Government and industry, will be ever greater in the foreseeable future.

Even the most ardent supporter would not suggest that value engineering holds the solution to all of our complex management problems. It is a discipline, however, designed to promote the achievement of essential functions at the lowest prudent cost. Value engineering, therefore, deserves our careful attention to determine whether or not it is being exploited to the fullest. A conference of this type provides all of us with the opportunity to explore the application of value engineering to a cross-section of industrial and defense operations. In the process, we gain an appreciation of the successes and problems of one another.

For the purposes of this conference, I consider it appropriate to address the contractor value engineering programs and, more specifically, that part of the program directly related to contractual requirements as specified by the value engineering clauses in defense contracts. It is in this area that I believe we here have our greatest mutual interest.

I have been asked to address the rhetorical question: "Does the Air Force really want value engineering?" The answer is obviously a resounding and unqualified "yes." Otherwise, I am sure we would not be here.

Why do we bother, then, to ask the question? Since its inception, the value engineering program has been beset with misunderstanding and inhibiting inuendo. It has been necessary for us to constantly reassure our contractors of our sincere intentions. This conference is only one of many such efforts. Though we believe much progress has been made in gaining better understanding, much remains to be done.

In 1967, the Defense Department directed the Logistics Management Institute (LMI) to undertake a study to determine whether significant opportunities exist for increasing defense industry participation and effectiveness in the DOD value engi-

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neering program. Also, the General Accounting Office (GAO) conducted a review of the Defense Department to determine how the value engineering progam was being managed.

The findings and conclusions of these two reviews are strikingly similar. While recognizing past accomplishments, both reviews indicated that much greater savings could result from an improved and intensified value engineering program. The summary of the LMI review stated that ". . . significant opportunities exist for increasing defense industry participation and effectiveness in the DOD value engineering program through stimulating a much greater exploitation of the 'savings sharing' potential of industry-initiated Value Engineering Change Proposals (VECPs)."

Both reviews were in substantial agreement as to the factors which were inhibiting value engineering and what was needed to effect improvements. I would like to identify and briefly discuss some of these with you. First, however, to put value engineering in perspective, let us look at the general environment in which we operate and where we are today.

Past Value Engineering Experience

In the past five years, Air Force saving realized from approved Value Engineering Change Proposals was $103.8 million. These "saved" dollars became available for other urgent requirements.

In the Air Force, we have experienced a generally upward trend in VECP submissions, approvals and dollars savings since we first started using value engineering clauses in contracts. Frankly, while we derive some gratification from this record, when we consider the increased dollar value of contracts with value engineering provisions during these same years and the resultant increased opportunities for saving, we have to conclude that the growth has been less than spectacular.

The Air Force expects, starting in this FY 1970, and every year thereafter while defense spending remains substantially at the present level, to double each year the amount of dollar savings realized from VECPs. We will continue with this objective until we are satisfied that the potential of this program has been realized.

If this seems ambitious, reflect for a moment on the experience of the Air Force Systems Command (AFSC), which is representative:

- Only 31 contractors out of more than 200, or less than 15 percent, submitted any VECPs in FY 1969.
- Only 8 contractors submitted 10 or more VECPs.
- Several of our largest contractors submitted no VECPs during FY 1969.
- It is estimated that less than 20 percent of our contractors have ever submitted a VECP.

I could go on, but the evidence is clear. Where we get participation, we realize savings and there is every indication that the potential for increased participation is very real indeed.

It is not enough, of course, to just state we are going to get more VECPs and more savings. We must examine those factors which, to now, have tended to retard the program, and find ways to overcome them. At the same time, we must seek together new applications of value engineering and broaden the program even as we consolidate our gains.

If it is to be successful, value engineering must have the support of top management. This is true as far as it goes which, unfortunately, is not far enough. At no place has value engineering had more support from the top than in the Defense Department and yet, as indicated by the Logistics Management Institute and General Accounting Office reports, success is not complete. One problem lies in a general resistance to change even where the concept is accepted.

If the attitude is one of resistance to change, value engineering cannot thrive. It is a positive management attitude we need for a successful value engineering program; an attitude which accepts not only the concept of value engineering, but also the inevitability of the change which will result, the need for change, if we are to have progress, and the acceptance of the turmoil and controversy which may come from change as the price for that progress.

Sharing Arrangement Not Understood

At the risk of being quoted out of context by the adversaries of the so-called "military-industrial complex," I would like to observe that sharing arrangements inherent in value engineering contract provisions effectively put the Air Force and the contractor into partnership. But, as in all partnerships, the partners must contribute to the accomplishment of some common objective and, if they are successful, both should benefit. The objective in this instance is to find a way other than that specified in the contract to perform or provide some required function for a lesser total cost. The elements which contribute to this partnership are generally as follows:

- The Air Force must assure that the incentives in the value engineering clause are adequate to motivate the contractor.
- The contractor must take the initiative in generating and submitting properly prepared VECPs.
- The Air Force must give VECPs objective and expeditious evaluation and communicate to the contractor the decisions.
- For those proposals approved, the contractor must be compensated in accordance with the terms of his contract.

Sounds simple, doesn't it? Unfortunately, like many things that appear simple, it is exceedingly complex. Let us just look at these "partnership contributions" one at a time.

First, the Air Force must assure that the incentives in the value engineering clause are adequate to motivate the contractor. Since provision for value engineering was first incorporated into the Armed Services Procurement Regulation (ASPR) in 1962, it has been substantially revised three times. The most recent of these revisions is dated June 1, 1967. Each revision broadened the areas in which value engineering could be applied contractually, improved the opportunities for the contractor to share in the savings which result from his efforts, and reiterated the DOD support for the program. And yet, as we noted, savings resulting from the program have not increased at a much greater rate than have defense expenditures and contracts with value engineering clauses. It would seem that either the incentives are not adequate, they are not being properly applied, or they are not properly understood.

We are inclined to discount the first explanation—that incentives are not adequate—if for no other reason than that the response by some contractors *is* proof to the contrary. Data furnished the Logistics Management In-

stitute for its study by five contractors indicated that they were realizing a return on their value engineering investment ranging from 6:1 to 21:1, with the average being somewhat more than 10:1. The LMI study did recommend, however, that DOD closely monitor experience and problems under current ASPR value engineering provisions and make timely corrective revisions, as necessary, to maintain strong motivation for industry VECP activity. This, from an Air Force standpoint, we intend to do.

With regard to the second possible explanation—that value engineering incentives are not being properly applied—contractors have been consistently critical of DOD "customer" attitude in the area of contract negotiations concerning value engineering incentive clauses.

As stated in the LMI report, contractor personnel assert:

- They have often been unable to negotiate a value engineering clause.
- They have had difficulty in negotiating clauses providing for contractor sharing of future acquisition value engineering saving.
- The contractor sharing percentages which they are able to negotiate are often not in line with DOD policy.

While there was probably justification for these assertions early in the program, they continue even after the causes have, for the most part, been corrected. Frankly, they begin to have the hollow sound of excuses.

Consider these facts from the LMI report:

- The dollar value of DOD contracts containing value engineering clauses rose from $3.3 billion in FY 1963 to $22.5 billion in FY 1967.
- As a percentage of total DOD procurement, contracts with value engineering clauses rose from 12.6 percent in FY 1963 to 57.3 percent in FY 1967.
- Examination of FY 1967 contracts with value engineering clauses indicates that contract negotiators in DOD are including value engineering clauses in the major dollar portion of their contracts; and are negotiating value engineering clauses providing not only for contractor sharing of instant contract, but also future acquisition and collateral savings.
- On the contracts examined by LMI, the sharing features fit squarely within the "norms" of the Armed Services Procurement Regulation.

LMI concluded, "We found no support for a claim that this area of value engineering clause contract negotiations is a general problem, although there may have been specific instances in the past where industry criticism was justified."

The evidence and the conclusions notwithstanding, in the Air Force, we will continue to watch this area closely to assure that our contracting officers and negotiators comply with the intent, as well as the letter, of the ASPR. At any rate, we do not find evidence that the lack of application of value engineering incentives is a serious problem at this time.

The third explanation for the lack of response to value engineering incentives was that they were not understood. Again referring to the LMI report, it found that:

- Top industry management does not always fully understand the intent and objectives of the DOD VECP program and, consequently sometimes fails to give its full support. Where top management does fully understand the program's objectives, we usually find aggressive, successful contractor VECP programs.
- Where contractors focus their attention on the "savings sharing" potential to themselves from the DOD VECP program, and relate these shares to augmentation of their income and to return on their value engineering investment, we found top management support was usually not a problem.
- Some contract administration and comptroller personnel in defense industry do not fully understand the intent and objectives of the DOD VECP program and, consequently, fail to pursue it aggressively and fail to give proper visibility to industry benefits realized from the program.

It would not be realistic to draw any conclusions from these general findings. It does seem evident, however, that the failure of value engineering incentives to do the job can be more clearly attributed to the fact that they are not understood, rather than to either a lack of adequacy or a lack of application.

This undoubtedly has a bearing on the second element of our partnership, which was that the contractor must take the initiative in generating and submitting VECPs. If the incentives are not understood, it would follow that the contractor would not be motivated to submit VECPs.

We Want a Professional Effort

The submission of VECPs by the contractor is voluntary. If the program is to experience the growth which we see for it, contractor management, from top down, must become enlightened. This must be followed up with positive and aggressive action.

Don't misunderstand me. We do not just want VECPs. We want a professional effort.

VECPs should have the same care and thoroughness in preparation as any other industry proposal to a customer. The LMI study recommended greater industry emphasis on such matters as:

- Reduction of length of VECP processing time within industry itself.
- Improvement of the quality of industry VECPs with more complete supporting technical information and cost analysis.
- Establishment of early and continuing VECP communications channels with DOD counterparts.

I would like to add to these some recommendations of my own for our industry partners.

First, take a look at your Value Engineering Program and, if it needs it, revitalize it. Make sure it is an organized effort and that it has your support in attitude, as well as support in concept. Make sure it is not concentrating in the cost reduction area to the exclusion of the more difficult, but profitable, VECP. Establish goals for your Value Engineering program and follow through—not goals on numbers of VECPs, but goals on dollars accruing to you.

Second, look for ways to expand the application of value engineering to your advantage

For example, do you have a Value Engineering Program for your subcontractors? You stand to benefit from their efforts. The evidence is that very few contractors are giving this aspect of the program the attention it deserves.

It is not my intention to gloss over the part the Air Force plays in the submission of VECPs. In addition to the motivation provided by the incentives, the Air Force must demonstrate by its actions that it is receptive if we are to succeed. This is the third element of the partnership: that the Air Force must give VECPs objective and

expeditious evaluation and communicate to the contractor its determination.

To quote from the LMI report: "The belief of many in defense industry that their DOD 'customer' attitude is often out of step with the intent of the DOD VECP program is a general problem and *may be the most serious single current impediment* to more aggressive defense industry VECP activity." It was the LMI conclusion that "defense industry will increase its VECP activity significantly when it is generally convinced that its DOD 'customer'—at all levels of Defense Department—is receptive to industry initiated VECPs."

Further, the major industry criticisms, as reported by the LMI, in the VECP processing area were:

- Too many industry VECPs are disapproved by DOD.
- Too many industry VECPs are in the hands of DOD for "excessively long" times before being approved or disapproved.
- Too many industry VECPs are disapproved with no reasons or with only cryptic reasons for disapproval furnished the submitting contractor.
- Contractors are not given an opportunity to correct defective VECPs so that they can be approved.
- "Feedback" information to industry from DOD on the status of its VECPs is generally inadequate.

Although these are criticisms against DOD, the Air Force readily admits its share of the responsibility. As these and other problems are identified, we take action to overcome them.

Pertinent to the criticism that too many VECPs are disapproved, we want approved VECPs because approvals mean savings. Of course, the VECP must be adequately prepared and properly supported, which is the responsibility of the contractor. But the Air Force must assure that those with merit are not disapproved because of an anti-change attitude or some other insufficient reason.

We maintain management visibility in this area by requiring a report stating the reasons for disapproval on any VECP on which the savings are estimated to exceed $50,000. Each succeeding level of management, through DOD, has an opportunity to question the judgment of the disapproving organization. Although this does not solve all our problems in this area, it does tend to inhibit capricious disapproval actions.

As far as processing time on VECPs is concerned, we in the Air Force are making progress. A "bench mark" of 60 calendar days processing time from submission by the contractor to approval or disapproval by the contracting agency has been established by DOD. Each of the Departments has accepted a goal stated in terms of a percentage of VECPs received which will be processed in no more than 60 days. The Air Force goal, which is by far the most stringent of any of the DOD organizations, is that 77 percent of all VECPs must be processed within 60 days. In FY 1969, we made this goal.

In the area of communications, where it is alleged that the reasons given for disapprovals are not adequate or "feedback" is deficient, we will continue to strive for improvement.

We in the Air Force will continue to seek ways to create a more positive climate for the reception of VECPs. We are sensitive to the charge that a negative "customer" attitude may be the most serious single impediment to industry VECP submissions. We intend to demonstrate that we are "in step" with the intent of the VECP program.

The fourth and last element of our industry-Air Force partnership is that the contractor must be compensated in accordance with the terms of his contract. I mention this only because there have been reported instances within DOD when VECPs have been disapproved, and then processed as engineering change proposals, depriving the contractor of the opportunity to share.

Also, there are reported instances where subsequent to the submission and approval of a VECP, attempts were made to negotiate sharing arrangements less favorable to the contractor than those contractually specified.

These, or any similar actions, are contrary to the intent of the VECP program and will be dealt with positively if they come to our attention.

In conclusion, I hope I have answered the question as to whether the Air Force really wants value engineering. If you had doubts, I hope these doubts have been dispelled. I want to leave you with the impression that the Air Force is far from satisfied with our VECP progress to date. We are not here to take comfort in our past accomplishments, but to dedicate ourselves to an even greater effort.

We must face the fact that there are forces inherent in the Air Force and industry which work against the achievement of our objectives. It is our collective management responsibility, through the demonstration of a positive attitude, to counteract these negative forces.

I am confident that the Air Force, in partnership with industry, and to our mutual benefit, will find the way to give the VECP program new and vigorous life. Your success, to date, is simply a prologue to the accelerated efforts you will be called upon to make in the coming years. For what we know now about the potential of value engineering indicates we have a long way to go in exploiting it.

Modular Combat Radio Proposed by Army

A modular tactical radio communication system, adaptable to different combat needs, has been proposed by the Army Combat Developments Command (CDC), Fort Belvoir, Va. The system would take advantage of technological advances in microelectronics to reduce costs and logistic support problems through the development of common-use modules.

As envisioned by CDC, the system would consist of a family of interchangeable common units, elements, modules, or subassemblies, providing numerous configurations to meet specific mission requirements of various users, including aircraft, vehicles and manpacks.

To reduce or eliminate enemy interference, countermeasures actions and frequency allocation problems, each radio configuration would possess only those capabilities necessary to meet normal communications needs.

High reliability and low failure rates would provide the system with average trouble-free, in-service periods of years rather than just days or weeks. Equipment would then be scheduled for replacement at the end of specified periods of time.

According to CDC, configurations or major assemblies could consist of replaceable modules with cost and reliability levels permitting disposal-on-failure as more efficient and economical than module repair.

ABOUT PEOPLE

DEPARTMENT OF DEFENSE

Lt. Gen. Arthur W. Oberbeck, USA, has assumed the position of Dir., Weapons Systems Evaluation Group, Office of the Dir. of Defense Research and Engineering.

Hugh McCullough is the new Special Asst. to the Asst. Secretary of Defense (Installations and Logistics).

Maj. Gen. Thomas H. Scott Jr., USA, has succeeded **Maj. Gen. Robert C. Kyser,** USA, as Dep. Dir., Defense Supply Agency, Cameron Station, Alexandria, Va. Maj. Gen. Kyser has retired.

Rear Adm. Fowler W. Martin, SC, USN, is now Commander, Defense Electronics Supply Center, Dayton, Ohio.

DEPARTMENT OF THE ARMY

Maj. Gen. George W. Casey has left the Combat Arms Group, Combat Developments Command, Fort Leavenworth, Kan., for duty in Vietnam as Asst. Commander, 1st Cavalry Division (Airmobile)

Col. Ernest Graves Jr. is the new Dep. Dir. of Military Construction, Office of the Chief of Engineers, Washington, D.C.

Col. Carroll N. LeTellier has succeeded **Col. Edwin R. Decker** as District Engineer, St. Louis District, Corps of Engineers, St. Louis, Mo.

Col. Charles L. Anderson, USA, has been named Dir. of Terminals, Hq., Military Traffic Management and Terminal Service, Washington, D.C.

DEPARTMENT OF THE NAVY

Rear Adm. James V. Bartlett, CEC, has been assigned dual positions as Vice Commander, Naval Facilities Engineering Command, and Dep. Chief of Civil Engineers of the Navy, Washington, D.C.

Rear Adm. Robert L. Long has been named Dep. Commander for Fleet Maintenance and Logistic Support, Naval Ship Systems Command, Washington, D.C.

Rear Adm. Gerald E. Miller is the new Asst. Dep. Chief of Naval Operations (Air), Washington, D.C.

Rear Adm. Frank H. Price Jr. is now Vice Commander, Naval Ordnance Systems Command, Washington, D.C.

Rear Adm. James H. Smith Jr. has been appointed Commander, Naval Aviation Integrated Logistics Support Center, Patuxent River, Md.

Rear Adm. (designee) Robert C. Gooding is the new Vice Commander, Naval Ship Systems Command, Washington, D.C.

Capt. Donald G. Iselin, CEC, has been named Dep. Commander for Planning, Naval Facilities Engineering Command, Washington, D.C.

Capt. Leslie O. Larson, SC, has been assigned as Dir. of Procurement, Office of Asst. Secretary of the Navy (Installations and Logistics).

DEPARTMENT OF THE AIR FORCE

Maj. Gen. William V. McBridge has assumed duties as Dep. Chief of Staff for Operations, Hq. Military Airlift Command, Scott AFB, Ill. His replacement as Dep. Chief of Staff, Materiel, is **Brig. Gen. Arthur W. Cruikshank Jr.**

Maj. Gen. Paul R. Stoney has assumed command of the Air Force Communications Service, Scott AFB, Ill.

Brig. Gen. Donald F. Blake replaced **Brig. Gen. Harold V. Larson** as Dir, Military Assistance and Sales, Office of the Dep. Chief of Staff, Systems and Logistics, Hq. USAF.

Defense Industry Bulletin Gets New Editor

Lt. Col. Matthew W. Irvin, USA, editor of the *Defense Industry Bulletin* since September 1968, has retired from the Army, as of October 31, 1969, after 26 years of service.

The acting editor of the *Bulletin* is now Capt. Frank W. Kafer, USAF, associate editor since joining the staff in February 1968.

Brig. Gen. Carroll N. Bolender is the new Dep. Dir. of Development, Office of the Dep. Chief of Staff, Research and Development, Hq. USAF.

Brig. Gen. John S. Chandler is now Asst. Dep. Chief of Staff, Systems, Hq. AFSC, Andrews AFB, Md. His former position as Systems Program Dir., F–111 Program, Aeronautical Systems Div., AFSC, Wright-Patterson AFB, Ohio, was filled by **Brig. Gen. Alfred L. Esposito.**

Brig. Gen. Robert E. Hails has been assigned as Dep. Chief of Staff, Maintenance Engineering, Hq. AFLC, Wright-Patterson AFB, Ohio. Also at Hq. AFLC, **Brig. Gen. William A. Jack** is the new Dep. Chief of Staff for Supply.

Col. Howard L. Byerley is now Inspector General for the Air Force Communications Service, Scott AFB, Ill. Also at Hq., AFCS, **Col. Thomas G. Sams** has assumed the duties of Dir., Command and Control, Office of the Dep. Chief of Staff, Operations.

Col. Jack M. MacGregor is the new commander of the Data Systems Design Center, Suitland, Md.

Col. Tipton P. Mott-Smith is the newly assigned Commander, Aero Propulsion Laboratory, AFSC, Wright-Patterson AFS, Ohio.

Col. Robert C. Mathis has taken command of the Rome Air Development Center, AFSC, Griffis AFB, N.Y. He succeeds **Col. George A. Zahn,** who has retired.

Col. Donald J. Seed has been named Chief of Procurement and Production, B–1 System Program Office, Aeronautical Systems Div., AFSC, Wright-Patterson AFB, Ohio.

Army Seeks Flying Gas Tank

Combat Developments Command, Ft. Belvoir, Va., proposes to use Army cargo and utility aircraft as flying tanks for fuel, oil and lubricants for units operating in forward operating areas. Consisting of 500 gallon containers, the system should be able to pump 400 gallons a minute through four hoses.

HEADQUARTERS, DEPARTMENT OF

Editor's Note: Organization charts appearing in the Bulletin are edited by the staff to reflect those elements of the various DOD organizations which are of interest to industry representatives. Organizations not involved in the DOD-industry relationship have been eliminated because of space limitations.

The information on personnel and telephone extension numbers is as current as is possible to obtain at the time we go to press.

SECRETARY

Honorable Stanley R
Col Kenneth B Coope
Col J K Bratton (Mili

UNDER SECRETARY

Honorable Thaddeus
Col James A Grimsle
Col Joseph R Ulatosk

DEPUTY UNDER SECRETARY (Operations Research)

Dr Wilbur B Payne	2E727	50083
Mr Abraham Golub (Asst Deputy)	2E727	76742

ADMINISTRATIVE ASSISTANT

Mr. John G Connell, Jr	3E732	52442
Mr R M Yingling (Deputy)	3E741	55879

GENERAL COUNSEL AND SP ASST FOR CIVIL FUNCTIONS

Mr Robert E Jordan, III	2E614	79235
Mr R Kenly Webster (Deputy)	2E614	74807

ASA (Financial Management)

Honorable Eugene M Becker	2E678	54291
Mr Richard L Saintsing (Deputy)	2E678	78121
Col Hugh J Bartley (Executive)	2E678	75215

ASA (Research and Development)

Mr Charles L Poor (Act)	3E390	56133
Dr Jacob B Gilstein (Deputy for Ballistic Missile Defense)	3E365	73558
Dr K C Emerson (Act Deputy) (Asst for Research)	3E379	57674
Col Robert K Moore (Executive)	3E390	55749

ASA (Manpo

Honorable William K B
Mr Arthur W Allen, J (Pers Mgt & Tng)
Col James W Love (Exe

C

General W C Westmoreland 3E668 7

VIC

General Bruce Palmer, Jr 3E668 7

ASSISTA

LTG W E DePuy

DIR FOR CIVIL DISTURBANCE PLANNING AND OPERATIONS

LTG W T Kerwin, Jr BF751B 73147

SAFEGUARD SYSTEM MANAGER

LTG A D Starbird (SAFSM) 43061

SECRETAR

Mr. William A.

THE JUDGE ADVOCATE GENERAL

The Judge Advocate General		
MG Kenneth J Hodson	2E444	75151
The Asst Judge Advocate General		
MG Lawrence J Fuller	2E444	76306
Executive		
Col T H Reese	2E444	54364

THE INSPECTOR GENERAL (Forrestal Building)

The Inspector General		
MG W A Enemark	5AD13	35174
Deputy The Inspector General		
BG A R Brownfield	5AD13	35172
Executive		
Col Gustav M Bacharach	5AD13	35170

DIRECTOR MANAGEMENT INFORMATION SYSTEMS

BG H C Schrader (Dir)	1D269	50678
Col E L Valenstein (Dep Dir)	1D629	50040
LTC L D Pence (Exec)	1D629	75503

DIRECTOR FORCE PLANNING ANALYSIS

BG J L Baldwin (Dir)	3C718	54617
Col R E Plett (Dep Dir)	3C718	71475
LTC G F Newton (Exec)	3C720	75628

DIRECTOR WEAPON SYSTEMS ANALYSIS

Mr R J Trainor (Dir)	1E600
Col A W Jones (Dep Dir)	1E600
Maj W L Hatcher (Exec)	1E608

COMPTROLLER OF THE ARMY

Comptroller of the Army		
LTG Frank J Sackton	3A716	52510
Deputy Comptroller		
Mr Eckhard Bennewitz	3A720	76659
Executive		
Col J A Kjellstrom	3A712	72027

ASSISTANT CHIEF OF STAFF FOR INTELLIGENCE

ACofs for Intelligence		
MG J A McChristian	2E464	53033
Executive		
LTC R H Groover, Jr	2E464	52968
Dep for Intelligence Support		
BG V J Fenili	2E464	53929
Dep for Intelligence		
BG D C Armstrong, III	2E474	72577

DEPUTY CHIEF OF STAFF FOR MILITARY OPERATIONS

Dep Cofs for Mil Operations		
LTG Richard G Stillwell	3E648	52904
Asst Dep Cofs for Mil Ops		
MG R T Knowles	3E634	75180
Executive		
Col A A Olson	3E648	74521
Dir of Operations		
MG W R Desobry	3E538	53310
Dir of Plans		
MG G H Woodward	3E530	55032
Dir of Intl & Civil Affairs		
BG A E Milloy	3A526	59084

DEPUTY CHIEF OF STAFF FOR PERSONNEL

Dep Cofs for Personnel		
LTG Walter T Kerwin	2E736	56003
Asst Dep Cofs for Pers		
MG W E Brinker	2E736	52250
Executive		
Col F E Blazey	2E733B	78060

DEPUTY CHIEF

Dep Cofs for Logis
LTG Joseph M H
Asst DCofs for Lo
MG F D Miller
Executive
LTC R W Patter
C, OFC of Mgt An
Col C H Dornac
Director of Mat A
Col C M McKee
Director of Ammu
Col A W Seidel
Director of Plans
BG J G Appel
Director of Army
Col D C Howell
Director of Instal
MG J C Dalrym
Director of Suppl
Col W D Pardu
Director of Maint
Col E F Boesch

& Commonwealt
1320 Wilson B

CHIEF, U.S. ARMY AUDIT AGENCY (Nassif Building)

Chief		
MG Herbert G Sparrow	436	22730
Deputy Chief		
Mr William Bishop	436	22830
Exec Off		
Col J B Bonham	436	22855

CHIEF OF MILITARY HISTORY (Temp Bldg C, 2nd and R Sts, SW)

Chief		
BG H C Pattison	2003	52064
Deputy Chief		
Col H A Schmidt	2007	52017

CHIEF OF ENGINEERS (Temp Bldg T-7, Gravelly Point)

Chief of Engineers		
LTG Frederick J Clarke	1127	5205
Deputy Chief of Engineers		
MG Carrol H Dunn	1223	5536
Executive		
Col Philip T Boerger	1228	7337

CHIEF OF PERSONNEL OPERATIONS

Chief of Personnel Operations		
MG F W Boye, Jr	1E732	56730
Deputy Chief of Personnel Operations		
BG R A Edwards, Jr	1E736	74337
Executive Officer		
Col W M Turner	1E734	59728

THE ADJUTANT GENERAL

The Adjutant General		
MG Kenneth G Wickham	2E532	50163
Asst The Adjutant General		
Col C A Stantiel	2E532	50163
Executive Officer		
Col Donald L Geer	2E532	50163

CH OF (F sta

Chief of Chaplains
CH (MG) Francis

HE ARMY CHIEFS AND EXECUTIVES

F THE ARMY

	3E718	53211
utive)	3E718	53211
st)	3E718	53211

Y OF THE ARMY

	2E722	54311
xecutive)	2E722	76806
ary Asst)	2E722	52947

DEPUTY UNDER SECRETARY (International Affairs)

Mr. James V Siena	3E736	72241
Col Lawrence M Jones (Executive)	3E736	72432

d Reserve Affairs)

	2E594	79253
ty)	2E594	55291
	2E591	71967

ASA (Installations and Logistics)

Honorable J Ronald Fox	3E606	52254
Mr Vincent P Huggard (Deputy)	3E616	59800
Col Nikitas C Manitsas (Executive)	3E606	52216

DIRECTOR OF CIVIL DEFENSE

Mr John E Davis	3E346	74484
Mr Hubert A Schon (Deputy Director for Operations)	3E336	59384
Mr Robert E Young (Executive Asst)	3E346	53374

F STAFF

LTC W B Steele (Exec) 3E668 52110

F OF STAFF

Col E P Forrester (Exec) 3E668 54371

CHIEF OF STAFF

3D656 50294

ADVANCED AERIAL FIRE SUPPORT SYSTEM MANAGER

MG J L Klingenhagen (MGR) 1B464 53080

STANO SYSTEMS OFFICE

BG W B Fulton 3C637 50022

HE GENERAL STAFF

ton 3E668 53542

DEP SECRETARY OF THE GEN STAFF (Staff Services)

Col A L Hamblen, Jr (DSGS) (White House LNO) 3E669 52776

DEP SECRETARY OF THE GEN STAFF (Staff Action Control)

Col J G Hill, Jr (DSGS) 3E665 57552

DEP SECRETARY OF THE GEN STAFF (Coordination and Reports)

Col T M Tarpley (DSGS) 3D643 73206

CHIEF OF PUBLIC INFORMATION

Chief		
MG Wendell J Coats	2E636	55135

CHIEF OF LEGISLATIVE LIAISON

MG William A Becker (Chief)	2C631	76767

CHIEF OF INFORMATION

Chief of Information		
MG Wendell J Coats	2E636	53135
Deputy Chief		
Vacancy	2E636	74482
Executive		
Col L E Stanford	2E636	74200
Asst Cinfo (Plcy & Op)		
Col L Breault	2E646	74359
Asst Cinfo (Plans & Prog)		
Col F Petruzel	2E646	74269
Policy & Plans Div		
Col E C Raleigh	2E637	73447
Comm Rel Div		
Col Robert W Leonard	2E631	75716
Public Information Div		
Col W Schabacker	2E641	55136

ARMY RESERVE FORCES POLICY COMMITTEE

Chairman		
MG Stuart D Menist	3B747	73391
Subcommittee on Army National Guard Plcy		
MG Henry W McMillan (Chairman)	3B747	73391
Subcommittee on Army Reserve Policy		
MG Stuart D Menist (Chairman)	3B747	74369

TAFF FOR LOGISTICS

Jr	3E560	54102
	3E560	75301
	3E560	79039
	5D3A&	44391
on	3E576	74944
	1E580	70973
	2C567	53282
ortation	3C565	50950
	2E572	74221
	1E558	52881
	611B&	44300

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rlington, Va.

ASSISTANT CHIEF OF STAFF FOR FORCE DEVELOPMENT

ACofs for Force Development		
LTG A S Collins, Jr	3E468	55775
Dep ACofs for Force Dev		
MG R R Williams	3E468	75584
Executive		
Col W T Moseley	3E468	55703
Dir of Air Defense		
BG C J LeVan	1E458	70316
Dir of Army Aviation		
MG J L Klingenhagen	3E486	52882
Dir of Cbr & Nuclear Ops		
BG W W Stone, Jr	3A480	57728
Dir of Doctrine & Systems		
BG R C Taber	3E480	75116
Dir of Plans and Programs		
BG G S Blanchard	3E522	56772
Dir of Org, Unit Tng & Readiness		
BG T J Camp, Jr	3E452	73725

CHIEF OF RESEARCH AND DEVELOPMENT

Chief of Research & Dev		
LTG A W Betts	3E412	78186
Dep Chief of Rsch & Dev		
MG Edward L Rowny	3E412	78187
Chief Scientist, DA		
Dr M E Lasser	3E424	72612
Executive		
Col W H Tucker, Jr	3E412	54997
Dir/Plans & Programs		
BG D D Blackburn	3E436	56768
Dir/Development		
Col J B Lamb (Act)	3E374	75063
Dir/Army Research		
Col G M Snead, Jr	3E374	73710
Dir/Missiles and Space		
Col N W Tobey	3E360	72449

CHIEF OFFICE OF RESERVE COMPONENTS

Chief, Ofc of Res Components		
LTG William R Peers	2E524	52786
Deputy Chief		
MG J M Hightower	2E524	56229
Executive		
Col C E Balthis, Jr	2E524	59488

ASSISTANT CHIEF OF STAFF FOR COMMUNICATIONS-ELECTRONICS

Acofs for Comm-Elct		
MG G E Pickett	2E258	56604
Dep Acofs for Comm-Elct		
BG E R Reynolds	2E254	52070
Executive		
Col J M Templeman	2E258	72180
Dir Plans & Programs		
Col H E Porter	2E261	53353
Dir Army Telecommunications		
Col M M Berry	17-A#	53196
Dir Tactical Systems		
Col E S King	26-D#	52344
Dir Frequency Management		
Col T N Doeppner	33-A#	52903

Greely Building
2100 14th St. N, Arlington, Va.

CHIEF OF SUPPORT SERVICES (Temp Bldg A, 2nd and R Sts, SW)

Chief of Support Services		
Col D F Munster	2043A	75017
Deputy Chief		
Col Vincent L Corrado	2047A	75029

CHIEF NATIONAL GUARD BUREAU

Chief, National Guard Bureau		
MG W P Wilson	2E394	59265
Deputy Chief		
MG F S Greenlief	2E394	75559
Executive		
Col Joseph R Jelinek	2E394	56701

CHIEF, ARMY RESERVE

Chief, Army Reserve		
MG W J Sutton	2E516	71784
Deputy Chief		
Col L W Fritter	2E516	71260
Executive Officer		
Col J F Kettler	2E516	54733

HAPLAINS
Building)

on 6B158 35221

THE PROVOST MARSHAL GENERAL (Forrestal Building)

The Provost Marshal General		
MG K W Gustafson	5A157	35109
Deputy		
Col J C Shoultz, Jr	5A157	35120
Executive		
LTC Frederick L Gemmer	5A157	35121

THE SURGEON GENERAL (Main Navy Building)

The Surgeon General		
LTG L D Heaton, MC	2054	63335
Deputy Surgeon General		
BG H B Jennings, Jr, MC	2056	64112
Executive Officer		
Col R P Campbell, MC	2056	63122

VECPs Save $84 Million in FY 1969

The Defense Department accepted 1,221 contractor Value Engineering Change Proposals (VECPs) during FY 1969, reducing Defense contract costs more than $84 million, according to the Office of the Assistant Secretary of Defense (Installations and Logistics). Through the value engineering clause in their contracts, the companies' shares of savings varied from 20 to 60 percent. The following companies had Hi-Dollar VECPs (net savings of at least $50,000 before value engineering sharing) accepted during FY 1969:

Aerojet General Corp.; Aircraft Armaments, Inc.; American Electric and Machine Co., Inc.; Apex Metal Stamping Co., Inc.; API Instruments Co.; ARF Products, Inc.; Aseco, Inc.; AVCO Corp.; Bell and Howell Co., Inc.; Bendix Corp.; The Boeing Co., Inc.; Bowen-McLaughlin-York, Inc.; Bulova Watch Co., Inc.; Burroughs Corp.

Caterpillar Tractor Co., Inc.; Chamberlain Corp.; Condec Corp.; Continental Aviation and Engineering Corp.; Crowell Constructors, Inc.; Cullman Metalcraft; Daily Tube and Form Co., Inc.; Day and Zimmerman, Inc.; Eastern Tool and Manufacturing Co.; EG&G, Inc.; Fairchild Hiller Corp.; Fruin-Colmon Contracting Co.

Galion Amco, Inc.; Garrett Corp.; F. W. Gartner Co.; General Dynamics Corp.; General Electric Co.; G.G. Green Inc.; Goodyear Aerospace Co., Inc.; Grumman Aircraft Engineering Corp.; Hayes International Corp.; Hercules, Inc.; Hochtief AG; Honeywell, Inc.; Hughes Aircraft Co.; Kaiser Jeep Corp.; Kennedy Van Saun Manufacturing and Engineering Corp.

Lasko Metal Products; Litton Industries Inc.; Lockheed Aircraft Corp.; LTV, Inc.; Magnavox Co.; Martec, Inc.; Martin-Marietta Corp.; Melpar, Inc.; North American Rockwell Corp.; Northrop Corp.; Ocean Products, Inc.; Olin Mathieson Chemical Co.; Philco-Ford Corp.; Raytheon Co.; RCA Corp.; R.C. Can Co.; REDM Corp.; Reflectone, Inc.; Rubber Fabricators, Inc.

Sanders Associates, Inc.; Sargeant-Fletcher Co.; Sperry Rand Corp.; Tacoma Boatbuilding Co., Inc.; Textron, Inc.; Thompson Aircraft Tire Corp.; United Aircraft Corp.; Westinghouse Electric Corp.; Wythe Tool and Machine, Inc.; Yankee Hill Machine Co.; Zenith Radio Corp.

Navy RDT&E Guide Available

The third edition of the "Research, Development, Test and Evaluation Management Guide," published by the Assistant Secretary of the Navy (Research and Development), is now available.

Identified as NAVSO P-2457, copies are $2.50 each from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Revised Edition of ITAR Available

The regulations on International Traffic in Arms (ITAR) have been revised by the Department of State. The publication includes excerpts from the Mutual Security Act of 1954 (as amended), Executive Order 10973, "Administration of Foreign Assistance and Related Functions," and Executive Order 11432, "Control of Arms Imports."

The August 1969 edition of the regulations, of interest to industry concerned with commercial exports of arms, ammunition, military equipment, and technical data relating thereto, is available without charge from the Office of Munitions Control, Department of State, Washington, D.C. 20520.

Contractor Retention of Classified Material

The Office of Industrial Security, Defense Supply Agency, reports that occasionally, during recurring inspections of contractor facilities, it has been discovered that a contractor is retaining certain classified information without proper authority. When retention of such material would materially assist the contractor in his performance on other government contracts, he may request authority to retain the material in accordance with paragraph 51 of the Industrial Security Manual (ISM) for Safeguarding Classified Information (Attachment to DD Form 441).

In several instances, contractors have stated that they had a valid need for retention of certain classified material and had actually requested necessary authority, but had been unable to establish communications with the former contracting officer to obtain the authority. Because of such situations, procedures have been incorporated in Change 2 to the ISM which will enable the contracting officer of a current classified contract to transfer material from a previous contract to the current contract. The revised procedure is intended to ease the problems encountered by contractors in obtaining retention authority when a "need to know" exists, and to assure that the material, which is retained, remains under government cognizance.

Classified material, transferred under these procedures, must be identified as follows:

- Top Secret and Secret material shall be identified in a list of specific documents unless, in the case of Secret documents only, the contracting officer has authorized identification by subject matter and approximate number of documents.
- Confidential material shall be identified by subject matter and approximate number of documents.

This material must also be identified as to its origin. Ultimate disposition or declassification responsibility will remain with its originating agency.

When retention approval is granted the contractor, the current contracting officer will so notify the contracting officer who had previous cognizance over the classified material. If the material involved is the information of a DOD user agency and is being retained by a contractor of a non-DOD user agency, or vice versa, or between non-DOD agencies, the concurrence of the original contracting officer must be obtained by the current contracting officer prior to granting the retention authority.

Application of Medical Knowledge to Operation of Aircraft and Space Vehicles

Major General Charles H. Roadman, USAF

In November 1959, the dream of a few farsighted, research-oriented Air Force medical officers came into reality with the organization of the U.S. Air Force Aerospace Medical Center. Assigned to the Air Training Command and located at Brooks AFB, Tex., the center was the initial step toward placing management of aerospace medical research and development, medical education, and certain clinical medicine practices under one command.

On November 1, 1961, the center was transferred to Air Force Systems Command (AFSC) as the Aerospace Medical Division (AMD). Certain aeromedical research-oriented units, already assigned to AFSC, were transferred to the AMD in early 1962, thus bringing all Air Force-sponsored aerospace medical research and development under the direction of one command. At the same time, AMD retained its educational and clinical medicine missions.

The philosophy behind this threefold mission is that each facet of the total effort supports the other two. It provides a favorable climate for rapid advancement in medical knowledge with wide and prompt dissemination of new concepts into medical and operational practice. Medical research and development account for the largest part of AMD's total effort. Roughly 70 percent of our budget, our physical facilities, and the talents of our professional and technical people is spent on research and development programs.

Clinical practice claims about 20 percent and the balance of 10 percent goes into medical education. Of course, there is a good deal of interchange in personnel and equipment among the three missions. The research people do some teaching and they may also participate in medical practice, particularly in connection with experimental programs. Clinical personnel do research and teaching, and the teaching staff engages in medical practice and research efforts.

The proportion of AMD's total effort, assigned to any one facet of the mission, does not necessarily reflect the relative importance of that area to the Air Force or to the nation. The educational function, for example, is the prime source of trained specialists in aerospace medicine, not only for this country but for many of our allies. A great many of the medical officials trained by AMD are now with the airlines, in aerospace industries, and with other government agencies, such as the Federal Aviation Agency and the National Aeronautics and Space Administration (NASA).

To carry out its triple-mission, AMD plans and directs the operation of five facilities at four geographic locations in Ohio, New Mexico and Texas. Each of these facilities has its own commander and their missions reflect the varied aspects of the AMD mission.

Wilford Hall Hospital and Epidemiological Laboratory

Lackland AFB, Tex., some 12 miles from the headquarters of the Aerospace Medical Division at Brooks AFB, Tex., is the home of two AMD units—Wilford Hall USAF Hospital and the U.S. Air Force Epidemiological Laboratory.

Wilford Hall USAF Hospital is the primary clinical component of the division. This 1,100-bed institution is the Air Force's largest hospital and one of two AMD units where all three phases of our mission—education, research and clinical medicine—are carried out. It serves Lackland, the basic training center of the Air Force, as a base hospital and provides medical care for a large local military population. It also serves the Air Force as a referral center for complex diagnostic problems on a worldwide basis. The hospital staff has the capability of performing any of the complicated surgical procedures that are

Major General Charles H. Roadman, USAF, is Commander of the AFSC Aerospace Medical Division. In previous assignments, he served as Command Surgeon for the North American Air Defense Command, and as Director of Aerospace Medicine, Manned Spaceflight, with the National Aeronautics and Space Administration. General Roadman earned a Bachelor of Science degree from Dakota Wesleyan University, and Bachelor of Medicine and Doctor of Medicine degrees from Northwestern University Medical School.

performed in most major medical centers, including kidney transplants and open heart surgery. It is the only Air Force hospital with a program for the treatment of chronic kidney ailments using the artificial kidney and, as the cancer treatment center for the Air Force, Wilford Hall maintains the central tumor registry.

This facility presently has the case histories of over 18,000 cancer patients in computer memory banks with more added each day. The computers can quickly identify the type of cancer and greatly expedite treatment procedures by rapidly identifying the most successful mode of treatment in past cases. "Big Willie," as the hospital has come to be known, has two other Air Force-wide missions. It is the sight and hearing center of the Air Force and, as such, is the home of the Air Force Central Eye Bank. From this facility fresh ocular tissue can be shipped to other Air Force medical facilities as required.

In the education portion of AMD's mission, Wilford Hall conducts over 40 medical education courses. These are primarily postgraduate training in the form of internships in medicine and dentistry, and residency training in 18 medical, surgical and dental specialties, plus hospital administration. Fellowships in 11 subspecialties are also available at Wilford Hall, the only Air Force hospital with a fellowship program.

The U.S. Air Force Epidemiological Laboratory, also located at Lackland AFB, is responsible for the investigation of epidemics that might pose a threat to Air Force personnel any place in the world. In 1966 this organization was instrumental in preventing an epidemic of meningitis among basic training students at Lackland. Early identification of the specific meningitis bacteria assisted the medical staff at Wilford Hall Hospital in treatment and enabled initiation of early preventive measures that halted the epidemic.

Aerospace Medical Research Laboratory

At Wright-Patterson AFB, Ohio, in our Aerospace Medical Research Laboratory (AMRL), research is conducted in the fields of toxicology, biomechanics, human engineering and life support. Founded 34 years ago primarily to fabricate and test new flying safety devices and systems for the protection of man in high-speed aircraft, this laboratory now represents a capability in man and equipment not duplicated anywhere in the free world.

Toxic hazard studies have been underway at AMRL for a number of years. These studies utilize a group of space cabin simulators known as "Thomas Domes." In one study all of the material to be used in the Apollo spacecraft was ground up and heated to out-gas into the chambers where laboratory animals were exposed. Object of the study was to determine what effect the trace contaminants might have on the animal's ability to perform. Studies of this nature can be conducted for any prescribed period of time, and a fall-out benefit of this and similar studies in the past is expected to be an increased knowledge of the effect of air pollution on urban population centers.

On a specially constructed vibration couch at AMRL, various frequency vibrations are produced to study their effect on man's ability to perform. In the early Titan missiles, fuel sloshing around in the tanks set up pogo vibration at lift-off. AMRL scientists, by producing this same vibration on the couch, were able to determine that these vibrations, though they posed no physical threats to our astronauts, would prevent them from performing necessary tasks during the critical period of lift-off. As a result of these studies, the Tital fuel system was redesigned and the pogo effect eliminated. Recently, this couch has been used to study some of the vibrations expected to be encountered in supersonic flight at low levels.

Aeromedical Laboratory

At Holloman AFB, N.M., the division's Aeromedical Research Laboratory maintains a large research animal colony. Here Rhesus monkeys and chimpanzees are taught to perform discrete tasks, while base-line data is kept on the individual animals and the species. This provides laboratory

THOMAS DOMES at the 6570th Aerospace Medical Research Laboratory are used to study toxic hazards from space capsule materials that might threaten man's safety during flight.

scientists excellent subjects for use in those experiments not feasible for the human volunteer.

The possibility of damage to a spacecraft in flight has raised the question of emergency procedures after an explosive decompression. Our concern is not only with the time of useful consciousness, but more specifically with the time available to save the crewman's life and to prevent permanent brain injury.

At the Holloman laboratory, trained chimpanzees have been exposed to a near vacuum for as long as three and one-half minutes. After recompression and with a four-hour recovery period, the animals performed at a level consistent with their capability before exposure. The exposure time of three and one-half minutes cannot be extrapolated directly to human beings, but we do know that man can withstand a much longer exposure than had previously been thought possible.

Human reaction to linear deceleration is of particular interest to scientists at Holloman. On the Daisy track, where a sled propelled down the track by compressed air is braked to a pre-programmed stop by water brakes, several studies have been conducted on man's limits in exposure to impact. Some of the more recent studies on the Daisy track have been the testing of the seat belt restraint mechanisms for the F–111 aircraft and the Apollo spacecraft.

School of Aerospace Medicine

The U.S. Air Force School of Aerospace Medicine is located with division headquarters at Brooks AFB, Tex. This organization was activated in 1917 as the Aviation Medicine Laboratory at Mineola, N.Y. The history and progress of the School of Aerospace Medicine from its activation is in a real sense the history and progress of aerospace medicine.

In 1949, several years before Sputnik, the school organized the first department of space medicine in the free world. Since that time it has played a key role in research in space cabin atmospheres, radiation hazards, disorientation, space nutrition, and a variety of other problems encountered in aerospace operations. The school conducts over 30 courses in specialized training that vary in length from three days to three years.

In the clinical medicine portion of our mission, the school's Aeromedical Consultation Service is responsible for the initial medical evaluation of NASA's prospective astronauts and the Air Force's aerospace test pilots. Similar medical evaluations are performed on personnel for a number of government agencies.

Because of this ability to accomplish very detailed medical evaluations, the school established a referral service for flying personnel several years ago. Anytime an air crew member's fitness for flying is questioned and it cannot be resolved at his home base, he is referred to the school for examination and evaluation. Nearly 50 percent of these questionable cases are returned to flying status after thorough, detailed medical evaluations. This program has resulted in potential savings to the taxpayer of well over $300 million in the past eight years.

Another example of systems-oriented work conducted by AMD organizations is the research on habitable atmospheres for space cabins at the School of Aerospace Medicine. These studies have been performed for NASA in validating the Gemini-Apollo cabin environments, and to validate atmospheres for planned Air Force space flight including the Air Force space flight.

Studies completed under this program indicate that no ill effects result from the use of an atmosphere composed of 70-percent oxygen and 30-percent helium at a pressure of five pounds per square inch. Other atmospheric studies have been with 100-percent oxygen, and mixtures of oxygen and nitrogen. As a result of these studies, we are now able to offer systems designers a choice of several cabin environments that will not impair the ability of astronauts to function.

In addition to specific mission achievements, AMD has made a concerted effort to support our forces in Southeast Asia. Besides providing trained medical personnel to medical facilities in Southeast Asia, AMD research and development personnel have been responsible for a number of items in direct support of combat forces there.

To provide comfort to pilots flying in unventilated aircraft at low altitudes in tropical climates, our researchers adapted a rubberized vest circulating chilled water through tubes from an ice chest, using an electric pump. The vest weighs approximately three pounds and is worn under the flying suit. The weight of the entire unit for two men is less than 50 pounds, including 25 pounds of ice, and it occupies about 1 cubic foot of space. In a humid atmosphere at temperatures of 115 degrees F., it cools two men for a period of two hours.

In 1963, the human engineering people in the laboratory at Wright-Patterson AFB started working on the theory of lateral sighting techniques for aircraft. A modified gunsight was devised from this lateral firing concept and tested in a C–47 aircraft. This led to the development of what we now know as "Puff, the Magic Dragon." Gunship II utilizing a C–130 aircraft and this same lateral firing concept is now in use in Southeast Asia.

Other developments in support of the Vietnam conflict include a new litter rack system for aeromedical evacuation flights on C–141 aircraft. This new development enables medical attendants to draw a litter from its normal flight position while a patient receives whatever care is needed. The litter then slides back and is locked in its regular position.

A second major development in aeromedical evacuation occurred during 1968 when the Air Force accepted the first C–9 aircraft. This is the only aircraft designed specifically for the air evacuation mission of Military Airlift Command and the interior configuration of the aircraft was designed by AMD personnel.

From the early days of aviation, components of the present Aerospace Medical Division have paralleled the extraordinary achievements of aircraft engineers in evolving high-speed, high-alitude flight systems by reconciling them with human needs and limitations. These advances have contributed significantly to the safety and comfort of passengers in modern jet transports. Since World War II the same progress has continued by extension to rocket aircraft and space vehicles. Eventually these innovations will be enjoyed routinely by travelers in supersonic transports, orbital gliders and interplanetary spacecraft. The work that is going on within the Aerospace Medical Division today will play a key role in this development.

Managing Government-Owned Equipment

Captain Hugh D. Byrd, SC, USN

On the organization chart of the Defense Supply Agency (DSA), the Defense Industrial Plant Equipment Center (DIPEC) at Memphis, Tenn., appears to be one of several like major field activities of this logistics agency, devoted to the management of common supplies for the Defense Department.

Such is not the case, however. DIPEC is to DSA as Alaska or Hawaii is to the other 48 states. While alike in many respects, in others DIPEC is startingly different from the other DSA field activities. The principal differences are threefold.

First, the other centers primarily manage expendable, non-recoverable items not requiring maintenance. DIPEC manages expensive end items or equipment which are not expendable and have long life expectancies.

Second, while the other centers deal almost entirely with military activities, many of DIPEC's customers are defense contractors who have been authorized to use government-owned industrial plant equipment (IPE) in connection with a defense production program.

The functional relationships between DSA/DIPEC and the other military components relative to IPE management also differ from the norm.

DIPEC is the logical outgrowth of a program initiated by the Military Departments immediately after the end of World War II. In order to preclude at least part of the difficulty experienced in increasing the national production base to meet defense production needs for World War II, each Military Department selected equipment becoming surplus as a result of the end of the war for retention against future mobilization needs. Within only a few years, the wisdom of this action was clearly demonstrated when the availability of this equipment permitted a much more effective and timely response to the defense production requirements generated as a result of the Korean conflict.

Subsequent to Korea, the Military Departments increased and strengthened their industrial reserve programs under the leadership of the Secretary of Defense. In-use inventories of this equipment were taken and records were established for each item. Reserve stocks developed into two categories. Some items were held in "packages" intended for use in production of specific end items of defense hardware, and others were held in a "general reserve" for application, as needed, to expand the defense production base. These stocks were used also to support current operating requirements so that the inventory would continue on a dynamic basis.

By the early 1960s, the program had grown to the point where it became clear that both management improvements and economies could be achieved by centralizing the program within one activity. DSA was the logical agency for the task and, accordingly, DSA was directed in December 1962 to establish a Defense Industrial Plant Equipment Center. After some nine months of planning, DIPEC became operational on Sept. 1, 1963.

Mission Objectives and Operation

DIPEC's major mission objectives can be summarized as:

- Managing the DOD General Reserve of Industrial Plant Equipment.
- Obtaining maximum reutilization of DOD-owned equipment in order to avoid new procurement wherever feasible.

DIPEC currently has central inventory records on approximately 450,000 individual items of IPE, with a gross acquisition value in excess of $4 billion. As an indication of its activity, DIPEC has, since its inception, obtained reutilization of over 77,000 items of equipment with an acquisition value of approximately $668 million.

The sites at which IPE is stored and maintained for the Services have been reduced from 14 to 4. The four are located throughout the continental United States (Mechanicsburg, Pa.; Columbus, Ohio; Atchison, Kan.; and

Captain Hugh D. Byrd, SC, USN, has been Commander of the Defense Industrial Plant Equipment Center since July 1968. In previous recent assignments, he served as Deputy Commander of the Defense Depot Memphis (Tenn.), and before that as Comptroller at the Boston Naval Shipyard. Capt. Byrd holds a B.S. degree from the University of North Carolina and an M.B.A.

DEFENSE INDUSTRIAL PLANT EQUIPMENT CENTER

MEMPHIS, TENNESSEE, 38102
Phone (901)743-3410

Editor's Note: Organization charts appearing in the bulletin are edited to reflect those elements which are of interest to industry representatives. Organizational elements not involved in the DOD-industry relationship are omitted because of space limitations.

Names and telephone numbers are as current as possible at press time.

COMMANDER
Captain Hugh D. Byrd, SC, USN

EXECUTIVE DIRECTOR
Hugh R. Carrington

OFFICE OF PLANNING AND MANAGEMENT
F.A. Morrin, Jr.

- Plans, Programs and Analysis Division
  - P.H. Coons
- Systems, Programming and Procedures Div
  - W.C. Wilson
- Procurement Division
  - E.T. Burns
- Management Engineering Division
  - T.H. Tuttle
- Mission Expansion Planning Office
  - W.C. Wilson

OFFICE OF COMPTROLLER
W.R. Miller

- Financial Management Division
  - M.L. Sikes
- Performance Analysis and Reports Division
  - J.T. Lawrence

OFFICE OF INSTALLATION SERVICES
T.E. Suggs

DIRECTORATE OF SUPPLY OPERATIONS
W.A. Wollard

- Management Support Office
  - B.F. Clark
- Metalworking Equipment Division
  - M.E. Smullen
- Electronic and General Plant Equipment Div
  - H.H. Harpel
- Support Division
  - J. Fulton, Jr.
- Storage and Maintenance Division
  - C.L. Moore

DIRECTORATE OF TECHNICAL OPERATIONS
W.M. Payne

- Engineering and Field Services Division
  - L.W. Goar
- Equipment Identification Division
  - R.L. Myers

TENANT ACTIVITY

A.F. Supporting Plant Equipment Branch
Headquarters A.F. Contract Management Division (AFSC)
Los Angeles, Calif. 90045

DEFENSE INDUSTRIAL PLANT EQUIPMENT FACILITIES

OPERATIONAL CONTROL	TECHNICAL DIRECTION
Defense Industrial Plant Equipment Facility Atchison, Kansas Fred B. Jensen	DDTC Tracy, Calif. Stockton Annex Lt. Col. G.F. Keyes, USAF DCSC Columbus, Ohio Don Butt DDMP Mechanicsburg, Penna. Ray Stine

Stockton Calif.) in proportionate relationship to the area density of major defense industries who are the customers of DIPEC's services. The reduction to four storage/maintenance sites permitted achievement of significant economies in facility maintenance costs and overhead, as well as making facilities available for other purposes.

In addition, procedures have been standardized and considerable progress has been achieved toward mechanizing many of the DIPEC internal processes on an IBM 360/40 system. Some defense contractors have started to make their inventory reports on either magnetic tape or punched cards. This process, too, has and will reduce costs by avoiding the preparation and transmittal of hard copy products between the contractor's mechanized property record systems and DIPEC's computer-based central inventory records. It is hoped that all contractors, who are currently using significant quantities of DOD-owned IPE and who have mechanized property record systems, will eventually adopt this simple reporting system. The cost savings are significant at both ends.

During the production buildup to meet our defense needs in Vietnam, the demand placed on DIPEC for production equipment (particularly for expensive, long lead-time machine tools) rose by 33 percent. These were some very interesting days, indeed, as DIPEC scurried around to find equipment for some of the really crash programs. For example, the Hydromatic Division of General Motors Corp. had an urgent requirement for equipment to produce the 20mm automatic gun. DIPEC furnished 754 items to this project. The equipment, valued at $8,187,561, constituted a 97.9-percent "fill-rate" on this equipment. On the much publicized M16 rifle program, DIPEC furnished 250 items, valued at $3,487,240.

In both these instances, as on many other projects, much of this expensive equipment would have been purchased new if DIPEC had not been able to make it available from its centralized inventory. These are just two examples, out of thousands, in which DIPEC has been responsive to defense needs—saving all-important lead time as well as dollars. DIPEC has successfully met many other high-priority requirements for support of ammunition, helicopter, vehicular and other end-item hardware programs.

Relationship with Military Departments and Contractors

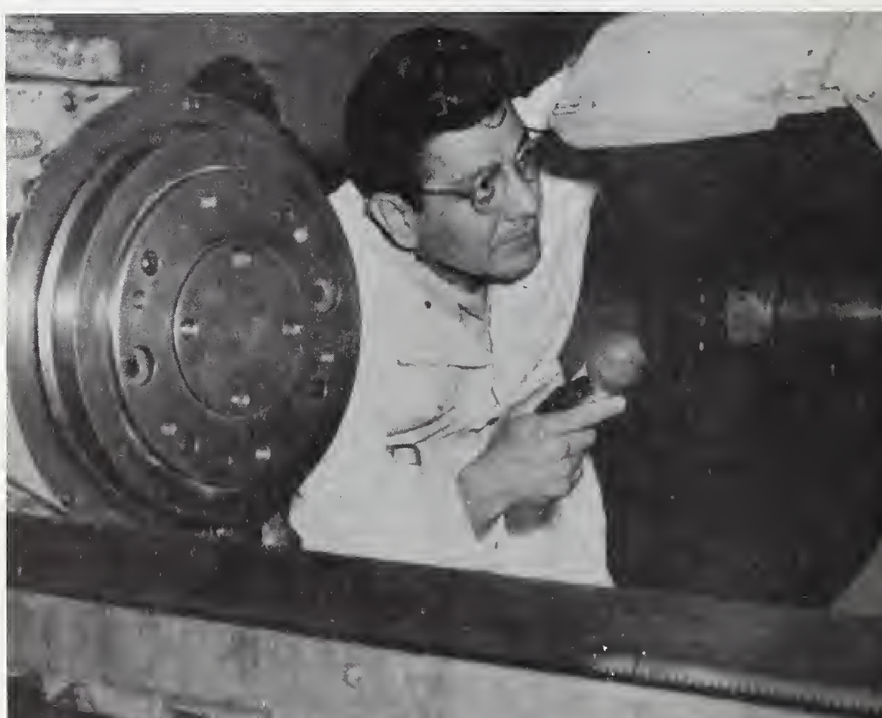
The DIPEC relationship with the Military Departments and their contractors is unique. A contractor is authorized to use government-owned IPE, when vital defense production cannot otherwise be obtained, under general criteria specified in the Armed Services Procurement Regulation and other policy directives. This authorization is included in facilities contracts or facility clauses to supply contracts. When a contractor is so authorized, he requisitions the authorized item from DIPEC through the administering contracting officer or his designee. DIPEC cannot accept requisitions directly from the contractor because DIPEC does not get copies of the authorizing contracts and, therefore, certification of validity by the local government representative is essential.

When the requisition is received, it is matched against the idle stocks in the general reserve to determine if a suitable item is available. This matching is done by equipment specialists who have years of actual experience in the various commodity areas in which they work. In the majority of instances the specific item requested is not available and it becomes necessary to screen for suitable substitutes. In fact, a very large percentage of the items supplied are substitutes. If a suitable item is available, which in our opinion will fill the requirement, it is offered to the requisitioner for his review and acceptance. Upon acceptance, the necessary movement instructions are initiated. If maintenance is required on the item, it is completed prior to shipment unless waived by the requisitioner.

If a suitable item is not available, a certificate of non-availability is issued in which case the contractor and the authorizing activity take further action to procure the item if the requirement is on a funded basis.

It is extremely difficult for the Military Services to project future requirements for IPE for several reasons. First, it is difficult to determine which end items of hardware will be required in any given situation. Second, and more important, until a contract is actually executed, it is im-

INSPECTION, PRESERVATION, repair and rebuild of industrial plant equipment is a major responsibility for DIPEC. Such work is performed at four facilities under the technical or operational control of DIPEC.



possible to forecast the specific items, if any, the successful bidder may be authorized. Lacking such projections from the Military Services, DIPEC uses historical demand as an indication of future need. Requirements of past years are used to arrive at demand rates which are, in turn, used to forecast future trends. The Military Services are now in process of developing mobilization requirements, so that DIPEC can establish mobilization reserve retention levels against which idle equipment will be held in anticipation of such demand.

It must be emphasized that DIPEC does not procure equipment for placement in the idle reserve. Only idle equipment, which is no longer required at its current location for the purpose authorized, can be placed in the idle reserve, and that is done only after three other conditions have been met. First, there must be no other immediate requirement; second, the item must be technically worthy of retention; and, third, the on-hand stock must be less than the projected retention level.

The review conducted prior to a decision to place an item in the idle reserve is extensive, particularly relative to its technical worth. The average item of IPE costs about $10,000 and weighs close to 6 tons. The costs inherent in preserving, shipping and storing this equipment are considerable. Therefore, we want to avoid any poor decisions that might result in disposal, after the costs to move the item to storage have already been experienced and when the item had no utilization potential in the first place. To this end, DIPEC has developed and uses an idle equipment appraisal technique which permits a uniform assessment of an item's technical value versus the costs to retain and reuse. This system largely eliminates personal judgment and permits effective documentation of the decisions reached.

Another important responsibility charged to DIPEC is the NIER program, the National Industrial Equipment Reserve. Some of this equipment, held in reserve to meet any national emergency, is also used in Federal programs designed to train persons for developing technical skills, especially among the hard-core unemployed. To date, DIPEC has furnished approximately 5,737 tools from the NIER to qualified technical schools and other programs in 40 states.

Assigned to DIPEC, in July 1965, was the DSA Industrial Equipment Reserve program. Special tooling from this program is furnished the DSA supply centers and their contractors for use in production of defense support materials, such as steel helmets, field kitchen equipment, concertina wire, and allied items. Maintaining files of engineering drawings, revising and developing new drawings to keep current with end-item changes is an important facet of this overall DSA Industrial Equipment Reserve responsibility.

Keeping Abreast of Changing Technology

In an era of ever-changing technology, DIPEC is geared to developing programs to keep abreast of such progress as we are presently witnessing in the field of numerically controlled machine tools. We are constantly updating our technicians in this and other fast-growing technologies. We do this in several ways. We send them to DOD schools or outside training classes. We visit trade shows and expositions. We participate in many industry and government technical seminars and association meetings. Also, we appreciate support given to us by industry in providing films, speakers and other training material.

The DIPEC organization is relatively straightforward and closely adheres to the DSA uniform structure. Overhead and staff functions are concentrated into the normal support elements. Direct operations are performed either by the Directorate of Supply Operations or the Directorate of Technical Operations. The Directorate of Supply Operations manages items, and the Directorate of Technical Operations develops the technical standards, specifications and catalogs under which items are managed.

DIPEC currently has a work force of approximately 475 people at its Memphis, Tenn., headquarters. Additional personnel are assigned to the storage/maintenance operations at the four sites. Originally, the nucleus of the center work force was drawn from the Military Department activities whose functions DIPEC assumed. To this nucleus has been added the most experienced equipment specialists and management personnel available.

Until now DIPEC has directly serviced only defense contractors and some large military production and maintenance facilities, such as arsenals and shipyards. However, many items of IPE used by these activities are identical or very similar to items used on DOD posts, camps, stations, bases and ships around the world. In August 1969, DIPEC began to provide the same level of IPE services for these activities as it has been giving to large military facilities and contractors. With this mission expansion, DIPEC will provide a single focal point for DOD-wide comparison of assets and requirements. Hopefully, this will maximize response to DOD equipment needs world-wide, while at the same time further reduce the need for new procurement.

Army To Get Electronic Teletypewriters

An electronic teletypewriter for use in forward combat areas has been developed for the Army under requirements set by the Combat Developments Command (CDC), Fort Belvoir, Va.

The equipment is designed in modular form to gain flexibility in operation, and utilizes electronic components to reduce weight. It is capable of operating on several coding systems, including the American Standard Code for Information Interchange, which is acceptable for use by information processing equipment, and the BAUDOT system, the Army-wide teletypewriter encoding system.

The new equipment is intended to provide teletypewriter capability over existing communications facilities, including tactical radio, field wire and radio relay, with a one-mile remote capability. Each unit can operate independently, with its own power supply and circuit adapter modules, giving each command flexibility to fit equipment to needs.

The equipment is intended for use down to the combat battalion level. CDC anticipates the unit to eventually replace six different sets now in the Army inventory.

Laboratory Planning—A New Order of Importance

Donald M. Ross

As viewed by the Air Force Rocket Propulsion Laboratory (AFRPL) located at Edwards AFB, Calif., laboratory planning has assumed a new order of importance. Prompted by budget reductions, advancing capabilities of competitive nations, and rising research and develment costs, AFRPL has had to substantially revise its method of planning. Increased attention and consideration is given the activities and technological progress of other major nations, especially those of the Soviet Union and Communist China. Never before has the technological race been so close, and the need so great, for carefully setting the goals and approach for future Air Force technology programs.

The action of Headquarters, Air Force Systems Command, in adding a function of foreign technology assessment, and associated manpower, to AFRPL has proven very valuable to the revised planning procedures. With two years of experience in the new function, the laboratory is more fully equipped, not only to set program goals but to benefit from knowledge of approaches being followed by foreign countries. From expanded knowledge and appreciation of the competition, the laboratory gains motivation for increasing its management effectiveness throughout its entire operations. This includes a determination to team with other laboratories and with Air Force weapon system development organizations—in this case, the Aeronautical Systems Division (ASD) and the Space and Missile Systems Organization (SAMSO) of the Air Force Systems Command.

One factor which has a constant sobering effect upon the laboratory is the tremendous growth that is occurring in the size of the Soviet scientific and engineering professional work force. Just 15 years ago the United States enjoyed a professional S&E (scientists and engineers) work force which was at least three times that of the USSR. Now the two nations are essentially equal in numbers of scientists and engineers. The Soviet's rate of expansion currently is three times that of the United States. During the past five years, S&E graduates in the United States have ranged between 7 to 9 percent of the total degrees granted annually. Correspondingly, the percentage is 40 to 42 percent in the USSR based on 16th and higher grade graduates. In June 1969, the United States awarded approximately 75,000 S&E degrees, as contrasted to approximately 230,000 for the Soviets. Forecasts show this situation will continue unchanged for the next 5 to 10 years.

Impressed with the realization that "technology program results must translate to weapon systems of the future," AFRPL doubled the man years normally spent with ASD and SAMSO in deriving and agreeing upon "technology needs." This, during the past year, has been at the expense of working closely with industry inputs as has been the laboratory's annual practice during the month of November. With procedural improvements effected, the laboratory will reestablish its planning ties with industry this fall. Summarized, the calendar of planning activities being followed by AFRPL is:

- **September:** Update technology status and forecast to systems organizations.
- **October:** Review threat and advanced systems objectives; update technology needs.
- **November:** Meet with industry.
- **December:** Complete program plan.
- **January and February:** Coordinate program plan with systems organizations and higher headquarters.
- **March:** Finalize program documentation.
- **April:** Update technical objective documents and distribute to industry and government organizations.
- **May:** Initiate contract program work statements.

Donald M. Ross is currently serving as Acting Director of the Air Force Rocket Propulsion Laboratory. Mr. Ross has been engaged in Air Force propulsion research and development since early 1939. In 1959, he was appointed Chief Scientist at AFRPL, and later became the laboratory's Deputy Director. Mr. Ross holds a B.S. degree in mechanical engineering from the University of Washington.

- **June:** Finalize in-house program documentation and work schedule.
- **July:** Update technological threat.
- **August:** "Catch our breath."

Overall, the strengthened approach to laboratory planning is expected to benefit both Air Force and industry as definition and description of goals, priorities and approaches become clarified in the laboratory's plan.

Categorizing Technology Needs

The laboratory divides its technology needs (TNs) into two categories: essential or desirable. For example, a TN spelling out the properties and characteristics of bipropellant liquid rocket components, needed for development of a low-cost space launch vehicle to specified cost objectives, would be rated "essential," inasmuch as demonstrated technology of the type needed does not exist. Likewise, a rating of "desirable" would be applied to a TN which specifies a new storable liquid propellant combination with a density-impulse higher than proven state of the art. In the latter case, achievement of weapon system objectives can be met, using existing third-stage technology and letting the stage "grow" to the size required. Under the worst condition, the second or first stage would also need to be augmented using available technology.

The ratings of essential and desirable influence the priority the effort-task receives from the laboratory's budget. Other significant influences on the priority assigned to a specific technology effort-task include: the importance of the postulated weapon system to the nation's defense, and the time period of need adjusted for the degree of risk associated with achieving the necessary technology.

A most difficult aspect of planning technology relates to defining the "N + 1" generation weapon system objectives where "N" is the next ICBM, air launched missile, or other weapon system to be developed. Properly, TNs aimed at N + 1 generation weapon system objectives should evolve from analyses of conceptual systems needed to meet the threat 7 to 12 years hence.

As an indicator of essentiality, ongoing and newly proposed rocket propulsion technology efforts are categorized as "E" (essential), "D" (desirable), and "F" (failed) describing their merit for fulfilling the objectives of the TNs.

Programming of Resources

While effective management of the laboratory resources necessitates orienting the majority of the resources to postulated weapon systems, not all the laboratory's program efforts fit the narrowness of a single weapon system or a single class of weapon systems. Some of the work, *e.g.*, "Mechanical Behavior of Solid Propellants," is applicable to all solid propellant applications. Other work, such as "Synthesis of New Propellant Compounds," is so fundamental that only an estimate can be made as to whether a resulting compound might be solid or liquid. What percent of the laboratory's annual budget should be "oriented" versus "general?" The fraction of the laboratory's budget contained in "general" is influenced by several dominating factors including:

- Availability of funds for basic and applied research.
- Adequacy of the present inventory of weapon systems.
- Innovation of radically new weapons or missions.
- Detail to which work tasks are reduced and approached with manpower and funds within the laboratory.

Often the decision to include or omit a proposed technology effort can be reached through application of a very simple management test, as follows:

- The proposed program, with its postulated merits and results, is understood and agreed upon by proposer and management.
- Now the program has been completed and the results achieved to the degree and extent proposed.
- What will the results achieve that are beneficial to the N, N + 1, or subsequent weapon systems?

Seemingly attractive programs often fail this simple test in that the proposed results provide very small, if not highly doubtful, evolutionary improvement to future systems. With major weapon systems, each costing many billions of dollars and each being developed many years apart, competition is not matched or surpassed through sponsorship of low-merit technology programs. Invariably the present, well proven state of the art continues in the next system rather than facing the cost and risk of proving and qualifying a small incremental improvement.

Application of fund allotments to the oriented portion of the program plan occurs rather easily, giving recognition to the priorities of the TNs (and their related weapon system objectives), and to the magnitude of expenditures needed to establish the needed technology on time. How far down the priority listing will the fund allotment stretch? The final results of the method clearly post the answer for recognition by all interested parties. In similar fashion, the picture is clear as to what needs are not funded. On the basis that the method is sufficiently sound for building a budgeted program, it works equally well in exercising budget cutbacks.

Several months ago, AFRPL approached the new procedures with trepidation, but with strong conviction that past procedures were not sufficient for the future. With a "first-round" of experience complete from its FY 1970/1971 program effort, the laboratory clearly sees strength growing from the method—team strength between laboratories, between laboratories and weapon system development organizations, and between the Air Force and the nation's industry.

CDC Establishes Post-1975 Methodology for Army

The Army Combat Developments Command (CDC), Fort Belvoir, Va., has announced a new methodology to guide developmental efforts for the post-1975 Army, and a new office to coordinate and manage this effort.

Called Army Combat Developments Program (ACDP) Methodology, it will take advantage of data resources and experiences derived during CDC's recent Army–75 study.

Among other aspects, it will detail requirements for cost-effectiveness analysis and methods to ensure extensive use of CDC's expanding data base. One feature will be the Doctrinal Position Paper, an annual report to the Department of the Army providing review and adjustment of priorities.

The new office, Assistant to the Chief of Staff for Program Operations, is under the command of Colonel Albert J. Brown.

DEPARTMENT OF DEFENSE
PRIME CONTRACT AWARDS BY STATE

Net Value of Military Procurement Actions by Department [a]

Fiscal Year 1969

(Amounts in Thousands)

STATE	Total Amount	Total Percent	Army	Navy	Air Force	Defense Supply Agency
TOTAL, U.S. [b]	$39,310,186		$11,731,424	$11,509,966	$11,440,942	$4,627,854
NOT DISTRIBUTED BY STATE [c]	4,061,395		1,065,143	1,197,675	947,568	851,009
STATE TOTALS [d]	35,248,791	100.0%	10,666,281	10,312,291	10,493,374	3,776,845
Alabama	407,726	1.2	203,235	43,650	78,148	82,692
Alaska	90,793	0.3	37,273	9,179	38,284	6,057
Arizona	343,730	1.0	151,830	53,050	128,514	10,336
Arkansas	117,179	0.3	37,576	7,297	46,089	26,217
California	6,824,433	19.4	1,311,537	2,231,379	2,640,933	640,584
Colorado	243,478	0.7	49,101	16,668	158,385	19,324
Connecticut	1,715,135	4.9	594,590	688,264	388,829	43,452
Delaware	46,762	0.1	11,915	6,468	6,391	21,988
District of Columbia	321,014	0.9	96,193	173,226	41,308	10,287
Florida	964,320	2.7	280,267	120,357	508,360	55,336
Georgia	932,901	2.6	92,280	60,310	715,459	64,852
Hawaii	114,627	0.3	36,827	52,483	20,786	4,531
Idaho	16,054	0.1	1,727	1,189	3,596	9,542
Illinois	932,495	2.6	482,729	128,127	155,087	166,552
Indiana	1,058,570	3.0	642,889	119,670	239,653	56,358
Iowa	202,119	0.6	56,122	40,886	42,354	62,757
Kansas	349,667	1.0	173,027	9,338	139,874	27,428
Kentucky	59,478	0.2	24,571	4,233	6,811	23,863
Louisiana	389,857	1.1	171,434	83,589	6,015	128,819
Maine	53,408	0.2	15,624	21,657	4,401	11,726
Maryland	731,282	2.1	151,087	330,422	214,106	35,667
Massachusetts	1,549,834	4.4	485,363	523,047	458,586	82,838
Michigan	683,202	1.9	461,992	51,015	93,006	77,189
Minnesota	741,169	2.1	277,114	232,227	197,524	34,304
Mississippi	218,337	0.6	13,671	139,884	21,604	43,178
Missouri	1,095,418	3.1	333,735	549,687	174,358	37,638
Montana	22,017	0.1	4,911	2,396	8,613	6,097
Nebraska	101,724	0.3	42,635	753	14,358	43,978
Nevada	27,113	0.1	10,930	4,219	10,580	1,384
New Hampshire	102,437	0.3	3,222	66,358	17,946	14,911
New Jersey	1,270,430	3.6	456,534	393,420	209,429	211,047
New Mexico	96,105	0.3	55,628	4,005	31,022	5,450
New York	3,074,316	8.7	735,690	1,469,888	571,968	296,770
North Carolina	514,739	1.5	274,795	93,574	22,440	123,930
North Dakota	35,807	0.1	5,327	791	10,398	19,291
Ohio	1,533,016	4.4	343,147	304,950	780,417	104,502
Oklahoma	173,438	0.5	34,695	12,289	81,392	45,062
Oregon	85,921	0.2	10,275	18,108	9,893	47,645
Pennsylvania	1,700,420	4.8	553,349	594,406	342,055	210,610
Rhode Island	119,268	0.3	13,491	82,886	4,427	18,464
South Carolina	172,520	0.5	89,349	35,543	23,656	73,972
South Dakota	3,478	*	2,700	—5,572	3,669	2,681
Tennessee	485,629	1.4	275,937	59,283	77,181	73,228
Texas	3,525,155	10.0	939,779	875,930	1,231,540	477,906
Utah	157,174	0.4	24,224	13,730	89,591	29,629
Vermont	85,445	0.2	69,122	2,898	12,304	1,121
Virginia	711,164	2.0	249,942	383,389	32,533	45,300
Washington	574,771	1.6	34,373	145,926	335,460	59,012
West Virginia	66,863	0.2	38,045	7,963	1,619	19,236
Wisconsin	393,646	1.1	254,222	47,824	35,309	56,291
Wyoming	13,207	*	250	32	7,112	5,813

For footnotes, see page 33.
*Less than 0.05 percent.

DEPARTMENT OF DEFENSE PRIME CONTRACT AWARDS BY STATE

Net Value of Military Procurement Actions by Fiscal Year [a]

Fiscal Years 1966, 1967 and 1968

(Amounts in Thousands)

STATE	Fiscal Year 1966		Fiscal Year 1967		Fiscal Year 1968	
	Amount	Percent	Amount	Percent	Amount	Percent
TOTAL, U.S. [b]	$35,713,061		$41,817,093		$41,241,125	
NOT DISTRIBUTED BY STATE [c]	3,999,758		4,435,384		3,992,991	
STATE TOTALS [d]	31,713,303	100.0%	37,381,709	100.0%	37,248,134	100.0%
Alabama	281,549	0.9	297,065	0.8	409,189	1.1
Alaska	71,666	0.2	85,648	0.2	106.513	0.3
Arizona	248,228	0.8	249,559	0.7	287,065	0.8
Arkansas	95,701	0.3	127,180	0.3	121,254	0.3
California	5,813,078	18.3	6,688,812	17.9	6,471,875	17.4
Colorado	255,893	0.8	210,409	0.6	262,753	0.7
Connceticut	2,051,560	6.5	1,935,895	5.2	2,355,135	6.3
Delaware	37,445	0.1	51,672	0.1	42,614	0.1
District of Columbia	328,111	1.0	357,666	1.0	349,771	0.9
Florida	766,955	2.4	799,005	2.1	975,824	2.6
Georgia	799,362	2.5	1,148,355	2.1	964,152	2.6
Hawaii	64,170	0.2	65,445	0.2	95,623	0.3
Idaho	20,004	*	14,772	*	17,051	*
Illinois	919,779	2.9	1,063,776	2.8	932,111	2.5
Indiana	1,068,259	3.4	898,247	2.4	1,107,453	3.0
Iowa	247,619	0.8	279,328	0.8	260,980	0.7
Kansas	312,629	1.0	398,918	1.1	292,293	0.8
Kentucky	70,057	0.2	124,294	0.3	60,366	0.2
Louisiana	302,906	1.0	656,031	1.8	460,463	1.2
Maine	51,340	0.2	56,558	0.2	75,209	0.2
Maryland	842,527	2.7	868,396	2.3	703,514	1.9
Massachusetts	1,335,952	4.2	1,422,272	3.8	1,618,741	4.3
Michigan	918,426	2.9	1,033,706	2.8	796,296	2.1
Minnesota	497,994	1.6	650,584	1.7	620,297	1.7
Mississippi	162,305	0.5	114,800	0.3	369,249	1.0
Missouri	1,112,665	3.5	2,277,597	6.1	1,356,871	3.6
Montana	13,779	*	78,452	0.2	20,453	0.1
Nebraska	80,478	0.3	103,522	0.3	120,401	0.3
Nevada	32,028	0.1	29,315	*	17,897	*
New Hampshire	109,591	0.3	162,551	0.4	155,995	0.4
New Jersey	1,090,122	3.4	1,234,768	3.3	1,108,440	3.0
New Mexico	86,230	0.3	80,472	0.2	87,214	0.2
New York	2,819,153	8.9	3,261,750	8.7	3,483,730	9.4
North Carolina	449,331	1.4	447,408	1.2	487,259	1.3
North Dakota	83,113	0.3	16,729	*	68,072	0.2
Ohio	1,588,955	5.0	1,602,593	4.3	1,640,525	4.4
Oklahoma	158,492	0.5	157,350	0.4	164,944	0.4
Oregon	89,983	0.3	99,319	0.3	119,719	0.3
Pennsylvania	1,665,087	5.3	1,649,091	4.4	1,727,314	4.6
Rhode Island	131,722	0.4	198,030	0.5	126,362	0.3
South Carolina	176,424	0.6	180,777	0.5	133,027	0.4
South Dakota	23,315	0.1	9,486	*	33,585	0.1
Tennessee	502,168	1.6	538,225	1.5	541,631	1.5
Texas	2,291,454	7.2	3,546,978	9.5	4,087,182	11.0
Utah	169,681	0.5	178,850	0.5	131,172	0.4
Vermont	81,066	0.3	100,157	0.3	104,957	0.3
Virginia	425,487	1.3	665,376	1.8	692,748	1.9
Washington	444,368	1.4	606,114	1.6	529,583	1.4
West Virginia	149,300	0.5	141,736	0.4	132,002	0.4
Wisconsin	364,684	1.1	383,602	1.0	406,409	1.1
Wyoming	11,112	*	32,868	0.1	14,851	*

For footnotes, se page 33.
*Less than 0.05 percent.

DEPARTMENT OF DEFENSE PRIME CONTRACT AWARDS BY STATE

Net Value of Civil Functions Procurement Actions [a] [e]

Fiscal Years 1966, 1967, 1968 and 1969

(Amounts in Thousands)

STATE	Fiscal Year 1966 Jul 65–Jun 66	Fiscal Year 1967 Jul 66–Jun 67	Fiscal Year 1968 Jul 67–Jun 68	Fiscal Year 1969 Jul 68–Jun 69
TOTAL, U.S. [b]	$878,301	$819,218	$845,295	$684,776
NOT DISTRIBUTED BY STATE [c]	43,532	40,875	44,810	41,727
STATE TOTALS [d]	834,769	778,343	800,485	643,049
Alabama	16,299	18,441	21,921	20,296
Alaska	15,808	2,818	7,250	1,364
Arizona	2,816	2,742	6,381	275
Arkansas	89,427	81,658	67,525	50,267
California	57,844	52,991	56,465	53,850
Colorado	922	1,539	3,471	2,616
Connecticut	5,197	7,212	5,761	6,010
Delaware	8,973	12,658	6,024	3,929
District of Columbia	866	1,071	299	1,799
Florida	26,273	35,334	30,439	24,059
Georgia	7,345	9,390	15,333	6,432
Hawaii	1,439	244	711	4,338
Idaho	5,822	19,556	26,290	33,359
Illinois	22,192	18,046	25,919	29,285
Indiana	25,080	18,052	21,627	11,127
Iowa	12,160	14,578	12,705	12,421
Kansas	12,884	11,611	7,153	9,256
Kentucky	20,219	21,701	19,438	11,394
Louisiana	54,921	40,600	41,074	25,769
Maine	1,628	1,326	1,087	749
Maryland	10,212	1,716	4,055	2,308
Massachusetts	5,065	2,703	4,879	2,058
Michigan	13,027	10,915	8,050	8,727
Minnesota	4,128	3,902	4,398	5,347
Mississippi	16,594	18,300	10,586	9,631
Missouri	29,799	30,941	26,417	25,186
Montana	3,774	21,840	52,656	45,139
Nebraska	8,613	6,112	6,860	3,378
Nevada	0	17	33	87
New Hampshire	1,693	107	156	238
New Jersey	3,303	2,163	4,388	3,773
New Mexico	3,748	5,955	9,157	5,755
New York	12,400	8,351	14,726	13,955
North Carolina	4,004	3,534	2,329	3,285
North Dakota	3,311	2,151	1,462	2,667
Ohio	15,884	12,442	18,639	22,795
Oklahoma	31,514	48,773	51,698	34,197
Oregon	86,906	44,354	29,995	15,332
Pennsylvania	37,776	37,760	30,445	30,072
Rhode Island	4,491	574	4,234	4,303
South Carolina	2,472	2,571	4,151	2,707
South Dakota	6,351	2,249	1,662	1,837
Tennessee	18,773	14,039	12,141	7,258
Texas	32,310	28,317	32,503	26,722
Utah	565	0	25	142
Vermont	58	90	101	385
Virginia	6,360	8,764	8,992	3,718
Washington	55,957	58,974	54,128	37,500
West Virginia	23,182	24,039	18,937	9,728
Wisconsin	4,094	5,122	4,775	6,203
Wyoming	290	0	34	21

For footnotes, see page 33.

*Less than 0.05 percent.

DOD Prime Contract Awards by State

Footnotes

[a]See Notes on Coverage below.

[b]Includes all contracts awarded for work performance in the United States. The United States includes the 50 states, the District of Columbia, U.S. possessions, the Canal Zone, the Commonwealth of Puerto Rico, and other areas subject to the complete sovereignty of the United States, but does not include occupied Japanese Islands and Trust Territories.

[c]Includes contracts of less than $10,000, all contracts awarded for work performance in the Commonwealth of Puerto Rico, U.S. possessions, and other areas subject to the complete sovereignty of the United States, contracts which are in a classified location, and any intragovernmental contracts entered into overseas.

[d]Net value of contracts of $10,000 or more for work in each state and the District of Columbia.

[e]Includes civil functions of the Army Corps of Engineers for flood control and rivers and harbor work. Civil functions data are shown separately, and are not included in military functions tabulations.

Notes on Coverage

It is emphasized that data on prime contracts by state do not provide any direct indication as to the state in which the actual production work is done. For the majority of contracts with manufacturers, the data reflect the location of the plant where the product will be finally processed and assembled. If processing or assembly is to be performed in more than one plant of a prime contractor, the location shown is the plant where the largest dollar amount of work will take place. Construction contracts are shown for the state where the construction is to be performed. For purchases from wholesale or other distribution firms, the location is the address of the contractor's place of business. For service contracts, the location is generally the place where the service is performed, but for transportation and communications services the home office address is frequently used.

More important is the fact that the reports refer to prime contracts only, and cannot in any way reflect the distribution of the very substantial amount of material and component fabrication and other subcontract work that may be done outside the state where final assembly or delivery takes place.

The report includes definitive contracts and funded portions of letter contracts and letters of intent, job orders, task orders, and purchase orders on industrial firms, and also includes interdepartmental purchases, made from and through other government agencies, such as those made through the General Services Administration. The state data include upward or downward revisions and adjustments of $10,000 or more, such as cancellations, price changes supplemental agreements, amendments, etc.

The estimated amounts of indefinite delivery open-end, or call type contracts for petroleum are included in the report. Except for petroleum contracts, the report does not include indefinite delivery, open-end, or call type contracts as such, but does include specific purchases or delivery orders of $10,000 or more which are placed against these contracts. Also excluded from the report are project orders, *i.e.*, production orders issued to government-owned-and-operated facilities such as Navy shipyards. However, the report includes the contracts placed with industry by the government-operated facility to complete the production order.

Two STRATCOM Units Merge

The Army Strategic Communications Command (USASTRATCOM), Fort Huachuca, Ariz., has announced the merger of two subordinate commands. The action, aimed at greater economy and increased operational effectiveness, involved the Joint Support Command, Fort Ritchie, Md., and the Army Strategic Communications Command—CONUS, Washington, D.C., which merged to form the National Communications Command (Provisional).

Colonel Thomas W. Riley, former commander of the Joint Support Command, heads the new organization, headquartered in the Hoffman Building, Alexandria, Va.

Bulletin Verifies Mailing List

Annual verification of the mailing list of the *Defense Industry Bulletin* is required by the Joint Congressional Committee on Printing and the Bureau of the Budget.

Coincident with the mailing of the October issue, each subscriber on the list in October was sent a mailing list verification card. Every subscriber, who wishes to receive the *Bulletin* during 1970 must return his card before January 1, 1970. The cards are self-addressed and postage is prepaid. Provision is also made to use the cards to correct addresses.

New subscribers, receiving the *Bulletin* for the first time in November, were not included in the mailing of verification cards, and are not required to respond to the survey. Their subscriptions will continue through 1970.

Future correspondence concerning editorial or circulation matters should be sent to the Bulletin's new address: Editor, Defense Industry Bulletin, Defense Supply Agency (DSAH-B), Cameron Station, Alexandria, Va. 22314.

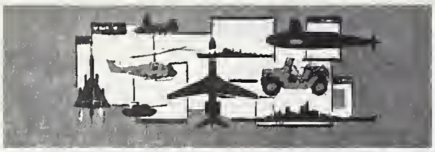
MERDC Testing New Structural System

A new structural system, the Universal Folded Plate (UFP), for use in prefabricated structures is undergoing tests by the Army Mobility Equipment Research and Development Center (MERDC), Fort Belvoir, Va. Limited testing has indicated that the system will produce a greater variety of structures than most other modular construction systems.

The basic building block is a folded diamond plate, which can be mass produced in either metal or reinforced plastic. The plates are then connected in either identical or reversed fold positions, creating the variety of structures available.

The metal and plastic plates can also be used in combination to provide structures of minimum weight and maximum light transmission. Water-sealing at the joints is provided by extruded compressible elastromeric gaskets, bonded to the edges of the plates.

The initial testing program includes panels made of 10 and 18 gauge steel and reinforced plastic.



DEFENSE PROCUREMENT

Contracts of $1,000,000 and over awarded during the month of September 1969.

DEFENSE SUPPLY AGENCY

2—The Defense Fuel Supply Center, Alexandria, Va., awarded the following contracts for gasoline and fuel oil:
Gulf Oil Corp., Houston, Tex. $3,921,000. DSA 600–70–D–0434.
Metropolitan Petroleum Co., New York, N.Y. $2,864,522. DSA 600–70–D–0448.
Atlantic Richfield Co., Philadelphia, Pa. $1,844,500. DSA 600–70–D–0408.
Hess Oil and Chemical Corp., Woodbridge N.J. $1,701,580. DSA 600–70–D–0439.

—**Plastoid Corp.**, Hamburg, N.J. $1,697,130. 33,860 one-mile reels of telephone cable (type WD1/TT). Defense Industrial Supply Center, Philadelphia, Pa. DSA 500–70–C–2603.

—**OJUS Industries, Inc.**, Miami, Fla. $1,110,720. 138,840 rolls of barbed concertina tape for the Army. Defense Construction Supply Center, Columbus, Ohio. DSA 700–70–C–2552.

5—Pettibone Mulliken Corp., Washington, D.C. $4,144,408. 239 rough terrain fork lift trucks for the Air Force and Marines. Chicago, Ill. Defense General Supply Center, Richmond, Va. DSA 400–70–C–1073.

—**International Harvester Co.**, Melrose Park, Ill. $1,382,312. 16 IHC Model H50-C loaders and 48 IHC Model 175B-2 loaders. Chicago and Libertyville, Ill. Defense Construction Supply Center, Columbus, Ohio. DSA 700–70–C–0800.

12—**Island Creek Coal Sales Co.**, Cleveland, Ohio. $1,684,260. 279,000 tons of bituminous coal. Coal Mountain, Mabley, Kelly, and Stowe, W.Va., and Brier Creek and Fies, Ky. Defense Fuel Supply Center, Alexandria, Va. DSA 600–70–D–0123.

16—**J. B. Manufacturing Co.**, San Antonio, Tex. $1,337,997. 550,250 men's short sleeve khaki cotton shirts. Defense Personnel Support Center, Philadelphia, Pa. DSA 100–70–C–0503.

18—**Delta Petroleum Co., Inc.**, New Orleans, La. $1,156,965. 2,876,605 gallons (55-gallon drums) engine lubricating oil. Defense Fuel Supply Center, Alexandria, Va. DSA 640–70–D–0586.

22—**Fire Trucks, Inc.**, Mount Clemens, Mich. $1,420,421. Fire fighting trucks. Defense Construction Supply Center, Columbus, Ohio. DSA 700–70–C–8250.

—**Chesebrough-Ponds, Inc.**, New York, N.Y. $1,019,549. 1,558,944 first aid dressings. Sherburne, N.Y. Defense Personnel Support Center, Philadelphia, Pa. DSA 120–70–C–0617.

24—**Glenn's All American Sportswear, Inc.**, Amory, Miss. $1,937,162. 590,818 pairs men's cotton uniform trousers. Sulligent, Ala., and Hatley, Miss. Defense Personnel Support Center, Philadelphia, Pa. DSA 100–70–C–0561.

25—**J. P. Stevens and Co., Inc.**, New York, N.Y. $2,287,030. 1,199,000 yards of tropical wool and polyester cloth (Air Force). Greer and Wallace, S.C. Defense Personnel Support Center, Philalphia, Pa. DSA 100–70–C–0558.

26—**Shell Oil Co.**, New York, N.Y. $3,741,324. Automotive gasoline for installations in the Southwest. Defense Fuel Supply Center, Alexandria, Va. DSA 600–70–D–0339.

—**Oregon Freeze Dry Foods, Inc.**, Albany, Ore. $1,895,152. 134,976 cans of cooked dehydrated shrimp. Defense Personnel Support Center, Philadelphia, Pa. DSA 130–70–C–E007.

—**Hercules Oil Co. of San Diego, Inc.**, Long Beach, Calif. $1,425,037. Fuel oil and gasoline for installations in the Southwest. Defense Fuel Supply Center, Alexandria, Va. DSA 600–70–D–0327.

—**United Fruit and Food Corp.**, Westwood, Mass. $1,279,807. 91,584 cans of cooked dehydrated shrimp. Edinburg, Tex. Defense Personnel Support Center, Philadelphia, Pa. DSA 130–70–C–E008.

30—**Mobil Oil Corp.**, New York, N.Y. $37,558,044. 317,286,300 gallons of JP-5 jet fuel. Ferndale, Wash., and Torrance and Los Angeles, Calif. Defense Fuel Supply Center, Alexandria, Va. DSA 600–70–C–0569.

—**Alpha Industries, Inc.**, Knoxville, Tenn. $1,152,402. 202,661 men's cotton-nylon coats with hoods (WRS OG-107). Defense Personnel Support Center, Philadelphia, Pa. DSA 100–70–C–0606.

—**Rolane Sportswear, Inc.**, Ridgly, Tenn. $1,048,788. 174,174 men's cotton-nylon coats with hoods (WRS OG-107). Defense Personnel Suppot Center, Philadelphia, Pa. DSA 100–70–C–0607.

CONTRACT LEGEND

Contract information is listed in the following sequence: Date—Company — Value — Material or Work to be Performed—Location of Work Performed (if other than company plant) — Contracting Agency—Contract Number.

DEPARTMENT OF THE ARMY

2—**Philco-Ford Corp.**, Newport Beach, Calif. $34,139,653. Shillelagh missiles. Lawndale Army Ammunition Plant, Hawthorne, Calif., and Iowa Army Ammunition Plant, Burlington, Iowa. Army Missile Command, Huntsville, Ala. DA-AH01-69-C-0059.

—**Hercules Engines, Inc.**, Canton, Ohio. $1,385,666 (contract modification). Model DS465-1A multi-fuel engines for 5-ton trucks for the Marine Corps. Army Tank Automotive Command, Warren, Mich. DA-AE07-67-C-4394.

—**Van Buskirk Construction Co.**, and **Buskirk-Cook Construction Co.**, Sioux City, Iowa. $1,265,507. Construction of recreation facilities, 25 miles of road, and parking areas, Rathbun Reservior Project, Iowa. Army Engineer District, Kansas City, Mo. DA-CW41-70-C-0011.

3—**AAI Corp.**, Cockeysville, Md. $2,953,500. 40mm grenade launchers. Army Procurement Agency, New York, N.Y. DA-AG25-70-C-0127.

—**Bucyrus-Erie Co.**, Evansville, Ind., $1,114,154 (contract modification). 12½-ton crawler mounted shovel cranes. Erie, Pa. Army Mobility Equipment Command, St. Louis, Mo. DA-AK01-69-C-A362.

4—**Pace Corp.**, Memphis, Tenn. $1,510,810. Surface flares. Camden and Russell, Ark., and Memphis. Picatinny Arsenal, Dover, N.J. DA-AA21-70-C-0137.

5—**Honeywell, Inc.**, North Hopkins, Minn. $2,417,907. Grenade fuzes. DA-AA09-70-C-0027. $1,413,258. Grenade fuzes. St. Louis Park, Minn. DA-AA09-70-C-0026. $5,000,000. Grenade fuzes. Twin Cities Army Ammunition Plant, Minn. DA-AA09-70-C-0026. Army Ammunition Procurement and Supply Agency, Joliet, Ill.

—**Scovill Manufacturing Co.**, Waterbury, Conn. $1,499,148. Grenade fuzes. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0028.

—**Bell and Howell Co.**, Chicago, Ill. $1,229,850. Grenade fuzes. Evanson, Ill. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0013.

—**Hercules, Inc.**, Wilmington, Del. $1,048,028 (contract modification). Production of propellants and explosives, and support services, Radford Army Ammunition Plant, Radford, Va. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-11-173-AMC-0037(A).

—**Martin K. Eby Construction Co., Inc.**, Wichita, Kan. $15,228,975. Construction work at the Cordell Hull Lock and Dam Project, near Carthage, Tenn. Army Engineer District, Nashville, Tenn. DA-CW62-70-C-0013.

—**Honeywell, Inc.**, Tampa, Fla. $4,500,000 (contract modification). Classified electronic equipment. Army Electronics Command, Fort Monmouth, N.J.

—**Continental Motors Corp.**, Mobile, Ala. $1,221,893 (contract modification). Remanufacture of multi-fuel engine assemblies, models LDS 465-1A and -1. Army Tank Automotive Command, Warren, Mich. DA-AE07-69-C-5296.

—**Campbell Chain Co.**, York, Pa. $1,512,631. Various size tire and cross chains. Army Tank Automotive Command, Warren, Mich. DA-AE07-70-C-0969.

8—**Kennedy Van Saun Corp.**, Danville, Pa. $3,343,338. Metal parts for 105mm projectiles. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0037.

—**Continental Motors Corp.**, Muskegon, Mich. $2,200,574. Kit cylinder sleeves and piston asemblies. Army Tank Automotive Command, Warren, Mich. DA-AE07-70-C-0955.

—**Applied Devices Corp.**, College Point, N.Y. $3,262,500. Radar station Hawk simulators. Army Missile Command, Redstone Arsenal, Huntsville, Ala. DA-AH01-69-C-1898.

—**Marquardt Corp.**, Van Nuys, Calif. $1,110,959. 66mm rocket warheads and precison liners. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-69-C-0374.

9—**The Boeing Co.**, Philadelphia, Pa. $2,133,054. Rear rotary blades for the CH-47. DA-AJ01-68-A-0005. $1,734,816. Forward rotary wing blades for the CH-47. DA-AJ01-68-A-0005. Army Aviation Systems Command, St. Louis, Mo.

10—**Chadwick and Buchanan**, Long Beach, Calif. $1,267,500. Restoration of the Santa Ana River channel from Santiago Creek to the Pacific Ocean. Army Engineer District, Los Angeles, Calif. DA-CW09-70-C-0015.

11—**Continental Motors Corp.**, Muskegon, Mich. $1,270,887. Engineering support of multi-fuel engines for 2½- and 5-ton trucks. Muskegon and Detroit, Mich. Army Tank Automotive Command, Warren, Mich. DA-AE07-67-C-5606.

—**E. D. Etnyre Co.**, Oregon, Ill. $1,126,477. 100 bituminous (BIT) distributors, 800-gallon tank type. Army Mobility Equipment Command, St. Louis, Mo. DA-AK01-70-C-1746.

15—**Bulova Watch Co.**, Providence, R.I. $2,099,900. M525 fuze head assemblies. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0045.

—**REDM Corp.**, Wayne, N.J. $1,392,750. M525 fuze head assemblies. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0044.

—**General Motors Corps.**, Indianapolis, Ind. $2,296,000. 81mm projectiles. Cleveland, Ohio. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0058.

—**R. G. LeTourneau, Inc.**, Longview, Tex. $10,374,000. Metal parts for 750-pound bombs. Lone Star and Longview, Tex. Army Ammunition Procurement and Sup-

ply Agency, Joliet, Ill. DA-AA09-70-C-0035.

—**American Machine and Foundry Co.**, New York, N.Y. $6,914,200. Metal parts for 750-pound bombs. Garden City, N.Y., and overseas. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0036.

—**Chamberlain Corp.**, Elmhurst, Ill. $5,320,-000. 81mm projectiles. Burlington, N.J. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0057.

—**Hayes Albion Corp.**, Albion, Mich. $1,932,-000. 81mm projectiles. Hillsdale, Mich. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0055.

—**Atlantic Research Corp.**, Alexandria, Va. $2,214,324. Redeye missile rocket motors. Army Missile Command, Redstone Arsenal, Huntsville, Ala. DA-AH01-70-C-0276.

—**Cadillac Gage Co.**, Warren, Mich. $1,352,-676 (contract modification). Commando V-100 armored cars, XM706. Army Tank Automotive Command, Warren, Mich. DA-AE07-69-C-0744.

—**General Dynamics Corp.**, Rochester, N.Y. $1,750,398. Radio teletypewriter sets, AN/GRC-142. Orlando, Fla. Procurement Division, Army Electronics Command, Philadelphia, Pa. DA-AB05-68-C-0035.

16—**Wilkinson Manufacturing Co.**, Fort Calhoun, Nebr. $1,165,500. Metal parts for 60mm M2 fin asemblies. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0049.

—**Raytheon Co.**, Andover, Mass. $3,135,156 (contract modification). Design and fabrication of factory test equipment for the improved Hawk system. Army Missile Command, Huntsville, Ala. DA-AH01-67-C-A028.

—**Ford Motor Co.**, Highland Park, Mich. $17,313,669. Increment for ¼-ton trucks (M-151A2). Michigan Army Missile Plant, Warren, Mich. DA-AE06-68-C-001.

—**Philco-Ford Corp.**, Newport Beach, Calif. $4,200,000. Long lead components for Chaparral ground support equipment. Anaheim, Calif. Army Missile Command, Redstone Arsenal, Huntsville, Ala. DA-AH01-70-C-0230.

17—**General Motors Corp.**, Indianapolis, Ind. $1,771,370 (contract modification). Transmission assemblies for the M551 Sheridan tank. Army Tank Automotive Command, Warren, Mich. DA-AE07-69-C-3436.

18—**Bell Aerospace Corp.**, Fort Worth, Tex. $11,550,000 (contract modification). Air Force UH-1H helicopters. Hurst, Tex. Army Aviation Systems Command, St. Louis, Mo. DA-AJ01-69-C-0028.

19—**Bell Helicopter Co.**, Fort Worth, Tex. $6,-625,000. CUH-1N helicopters for Canada. Army Aviation Systems Command, St. Louis, Mo. DA-AJ01-70-C-0234.

22—**General Motors Corp.**, Indianapolis, Ind. $5,087,337. M551 armored reconnaissance airborne assault vehicles. Cleveland, Ohio. Army Weapons Command, Rock Island Arsenal, Ill. DA-11-199-AMC-00610(W).

—**Western Electric Co.**, New York, N.Y. $55,-000,000. Contract extension for Safeguard research and development through Nov. 3, 1969.

23—**Walter Kiddie, Inc.**, Belleville, N.J. $1,-017,207. Air compressors for the Chaparral missile system. Army Missile Command, Redstone Arsenal, Huntsville, Ala. DA-AH01-70-C-0270.

24—**CONDEC Corp.**, Old Greenwich, Conn. $42,649,458. 1¼-ton cargo trucks. Charlotte, N.C., and Schenectady, N.Y. Army Tank Automotive Command, Warren, Mich. DA-AE07-68-C-2606.

—**Atlas Chemical Industries, Inc.**, Wilmington, Del. $16,226,966 (contract modification). Production of TNT. Chattanooga, Tenn. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-11-173-AMC-00531(A).

—**Hercules, Inc.**, Wilmington, Del. $13,894,-806 (contract modification). Production of propellants and explosives. Radford, Va. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-11-173-AMC-00037(A).

—**General Motors Corp.**, Detroit, Mich. $9,-917,631. Diesel engines for M561 trucks. Army Tank Automotive Command, Warren, Mich. DA-AE07-68-C-2597.

—**Lasko Metal Products, Inc.**, West Chester, Pa. $3,637,540. SUU-14A/A bomb dispensers. West Chester and Humboldt, Tenn. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-AA09-70-C-0070.

25—**Bendix Corp.**, Teterboro, N.J. $2,932,500. Stabilized platform and amplifier control power supply sets for the Pershing missile system. Army Procurement Agency, New York, N.Y. DA-AH01-69-A-0042.

—**Remington Arms Co.**, Bridgeport, Conn. $1,841,318 (contract modification). Load, assemble and pack small arms ammunition. Independence, Mo. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA-49-010-AMC-00003(A).

—**General Motors Corp.**, Indianapolis, Ind. $1,457,280. Transmission assemblies for the M113A1 family of vehicles. Army Tank Automotive Command, Warren, Mich. DA-AE07-70-C-0091.

26—**Ford Motor Co.**, Highland Park, Mich. $13,-614,150. ¼-ton utility trucks. Project Manager, General Purpose Vehicles, Michigan Army Missile Plant, Warren, Mich. DA-AE06-C-0001.

—**Stromberg-Carlson Corp.**, Rochester, N.Y. $2,660,000. Integration/maintenance management and technical operation services for the automatic telephone system in Southeast Asia. Army Electronics Command, Fort Monmouth, N.J. DA-AB07-67-C-0580.

—**White Motor Corp.**, Lansing, Mich. $2,-341,419 (contract modification). 2½-ton trucks. Project Manager, General Purpose Vehicles, Michigan Army Missile Plant, Warren, Mich. DA-AE06-69-C-0003.

—**A. D. Roe Co., Inc.**, Louisville, Ky. $1,-172,800. Construction of a non-commissioned officers open mess, Fort Knox, Ky. Army Engineer District, Louisville, Ky. DA-CA27-70-C-0014.

—**The Institute for Defense Analysis**, Arlington, Va. $1,076,738 (contract modification). Basic and applied research for DDR and E, and ARPA. Defense Supply Service, Washington, D.C. DA-HC15-67-C-0011.

—The Army Ammunition Procurement and Supply Agency, Joliet, Ill., awarded the following contracts:

Olin Mathieson Chemical Corp., East Alton, Ill. $37,168,808 (contract modification). Rocket propellant and ammunition components. Charleston, Ind. DA-AA09-69-C-0148. $11,621,988. 81mm projectile loading assemblies. Marion, Ill. DA-AA09-70-C-0108.

Eastman Kodak Co., Kingsport, Tenn. $16,738,338 (contract modification). Explosives. DA-11-173-AMC-00035(A).

Kisco Co., Inc., St. Louis, Mo. $16,258,-000. Metal parts for 105mm cartridge cases. DA-AA09-70-C-0083.

Norris Industries, Inc., Los Angeles, Calif. $7,699,920. Metal parts for 105mm cartridge cases. Pico Rivers, Calif. DA-AA09-70-C-0082.

Bell and Howell Corp., Chicago, Ill. $1,-235,812. Metal parts for M84A1 time fuzes. Evanston, Ill. DA-AA09-70-C-0067.

Kilby Steel Co., Anniston, Ala. $1,025,-640. 4.2-inch projectiles. DA-AA09-70-C-0066.

29—The Army Ammunition Procurement and Supply Agency, Joliet, Ill., issued the following contracts:

Uniroyal, Inc., New York, N.Y. $3,415,-366 (contract modification). Explosives, and loading, assembling and packing of cluster bombs. Army Ammunition Plant, Joliet, Ill. DA-11-173-AMC-00062(A).

Farmers Chemical Association, Inc., Tyner, Tenn. $2,689,050 (contract modification). Mixed acids. Chattanooga, Tenn. DA-11-173-AMC-00300(A).

Hercules, Inc., Wilmington, Del. $12,-780,600 (contract modification). Propellants and explosives. Radford, Va. DA-11-173-AMC-00037(A).

Rulon Co., Chicago, Ill. $1,865,694. Metal parts for delay plungers for M557 artillery fuzes. DA-AA09-70-C-0089.

Z D Products Div., Wells Marine, Inc., Costa Mesa, Calif. $2,140,820. Metal parts for M557 artillery fuze delay plungers. DA-AA09-70-C-0090.

—**FMC Corp.**, San Jose, Calif. $31,936,540. M113 series vehicles. Army Tank Automotive Command, Warren, Mich. DA-AE07-69-C-2600.

30—The following contracts were awarded by the Ammunition Procurement and Supply Agency, Joliet, Ill.

Day and Zimmermann, Inc., Philadelphia, Pa. $8,395,350 (contract modification). Load, assemble and pack 105mm cartridges without fuzes. Lone Star Army Ammunition Plant, Texarkana, Tex. DA-11-173-AMC-00114(A).

Donovan Construction Co., New Brighton, Minn. $9,590,880. Metal parts for 155mm high explosive projectiles. DA-AA09-70-C-0085.

Remington Arms Co., Inc., Bridgeport, Conn. $18,447,900 (contract modification). Load, assemble and pack .50 caliber ball and tracer cartridges. Lake City Army Ammunition Plant, Independence, Mo. DA-49-010-AMC-00003(A).

Sperry Rand Corp., New York, N.Y. $1,-938,500 (contract modification). Load, assemble and pack demolition charges and anti-personnel mines. Army Ammunition Plant, Shreveport, La. DA-11-173-AMC-00080(A).

Federal Cartridge Corp., Minneapolis, Minn. $5,969,300 (contract modification). Production of small arms ammunition. Twin Cities Army Ammunition Plant, New Brighton, Minn. DA-36-038-AMC-1099(A).

Firestone Tire and Rubber Co., Ravenna, Ohio. $6,239,500 (contract modification). Load, assemble and pack 40mm cartridges, and 8-inch and 175mm projectiles. DA-AA-09-70-C-0002.

Mason and Hanger, Silas Mason Co., Inc., Lexington, Ky. $3,391,374 (contract modification). Loading, assembling and packing of detonators and grenade fuzes. Army Ammunition Plant, Burlington, Iowa. DA-AA09-68-C-0468.

Stewart-Warner Corp., Lebanon, Ind. $1,558,275. Metal parts for 60mm high explosive projectiles. DA-AA09-70-C-0078.

National Presto Industries, Inc., Eau Claire, Wis. $30,775,307 (contract modification). Metal parts for 105mm high explosive projectiles. DA-AA09-69-C-0028.

Amron-Orlando Corp., Orlando, Fla. $3,020,832. Metal parts for point detonating fuzes. DA-AA09-70-C-0103.

Honeywell, Inc., North Hopkins, Minn. $9,958,329. Metal parts for point detonating fuzes. New Brighton, Minn. DA-AA09-70-C-0104.

Eison Brothers, Inc., Lodi, N.J. $4,-614, 686. Metal parts for 40mm high explosive projectiles. DA-AA09-70-C-0077.

Heckethorn Manufacturing Co., Dyers-Tenn. $2,309,708. Metal parts for 40mm high explosive projectiles. DA-AA09-70-C-0076.

Levinson Steel Co., Pittsburgh, Pa. $2,-609,550 (contract modification). Metal parts for 105mm high explosive projectiles. DA-AA09-69-C-0023.

Chamberlain Manufacturing Co., New Bedford, Mass. $9,689,281. Metal parts for 155mm high explosive projectiles. DA-AA09-70-C-0075.

Chamberlain Manufacturing Co., Elmhurst, Ill. $1,010,475. Metal parts for 105mm illuminating projectiles. Waterloo, Iowa. DA-AA09-70-C-0105.

Chamberlain Manufacturing Co., Waterloo, Iowa. $1,015,200. Metal parts for 2.75 inch rocket smoke warheads (M156). DA-AA09-70-C-0109.

—**North American Rockwell Corp.**, Anaheim, Calif. $1,370,998 (contract modification). Work on the Army Materiel Command Technical Data Configuration Management Systems. Frankford Arsenal, Philadelphia, Pa. DA-AA25-69-C-0042.

—**Collins Radio Co.**, Newport Beach, Calif. $1,500,000. Classified electronics. Army Electronics Command, Fort Monmouth, N.J.

—**Chrysler Corp.**, Detroit, Mich. $24,909,000. M60A1 tank and tank chassis, M728 combat engineer vehicles and repair/production equipment. Warren, Mich. Army Weapons Command, Rock Island, Ill. DA-AF03-70-C-0014.

—**Hughes Tool Co.**, Culver City, Calif. $1,-207,460. OH-6A light observation helicopters. Culver City and San Diego, Calif. Army Aviation Systems Command, St. Louis, Mo. DA-AJ01-69-C-0688.

—**General Dynamics Corp.**, Pomona, Calif. $2,203,877. FY 1970 engineering services for the Redeye missile system. Army Missile Command, Huntsville, Ala. DA-AH01-70-C-0303.

—**Glassman Construction Co., Inc.**, Washington, D.C. $3,463,000. Construction of shopping center, Forest Glen Annex, Walter Reed Army Medical Center, Md. Army Engineer District, Baltimore, Md. DA-CA31-70-C-0016.

—**United Aircraft Corp.**, Stratford, Conn. $9,435,002. CH-54B helicopters with engine air particle separators. Army Aviation Sys-

tems Command, St. Louis, Mo. DA-AJ01-70-C-0306.

—**Bell Aerospace Corp.**, Tucson, Ariz. $1,317,450 (contract modification). Technical services for installing and servicing the Environmental Data and Processing Facility. Army Electronics Command, Fort Monmouth, N.J. DA-AB07-68-C-0029.

—**Raytheon Co.**, Andover, Mass. $7,950,010. Engineering services for the improved Hawk missile system. Andover and Bedford, Mass., and White Sands Missile Range, N.M. Army Missile Command, Huntsville, Ala. DA-AH07-70-C-1095.

—**Metatronics Manufacturing Corp.**, Hicksville, N.Y. $1,044,765. Shipping and storage containers for Shillelagh guided missiles. Army Missile Command, Huntsville, Ala. DA-AH01-70-C-0310.

—**The Greater Anchorage Area Borough**, Alaska. $1,020,927. Construction of a sewage treatment plant, Anchorage, and connecting line to Fort Richardson, Alaska. Army Engineer District, Alaska. DA-CA85-70-C-0015.

—**Stanford Research Institute**, Menlo Park, Calif. $1,000,00. Continued study on anti-missile missile system. Huntsville, Ala., and Menlo Park. Safeguard System Command, Huntsville, Ala. DA-HC60-69-C-0004.

—**Western Electric Co.**, New York, N.Y. $8,909,488. Continuation of radar measurement program in support of Kwajalein National Missile Range. Bell Telephone Laboratories, Whippany, N.J., and RCA, Moorestown, N.J. DA-HC-60-69-C-0001. $17,800,000 (contract modification). Advanced development studies for ballistic missile defense. Bell Telephone Laboratories, Whippany, N.J., Cornell Aeronautical Labs, Buffalo, N.Y., TRW Systems Inc., Redondo Beach, Calif. and other subcontractors. DA-HC60-69-C-0008. Safeguard System Command, Huntsville, Ala.

DEPARTMENT OF THE NAVY

2—**Westinghouse Electric Corp.**, Pittsburgh, Pa. $29,000,000. Nuclear reactor compartment components. Naval Ship Systems Command, Washington, D.C. N00024-69-C-5101.

—**Hughes Aircraft Co.**, Canoga Park, Calif. $4,100,000. Design, documentation, manufacture and test of Walleye II missiles. Canoga Park and Tucson, Ariz. Naval Purchasing Office, Los Angeles, Calif. N00123-69-C-1539.

3—**Honeywell Inc.**, St. Petersburg, Fla. $1,116,360. Repair of inertial components in support of the Polaris missile guidance system. Naval Strategic Systems Project Office, Washington, D.C. N00030-70-C-0088.

—**Hughes Aircraft Co.**, Culver City, Calif. $2,200,000. Poseidon missile guidance system electronic assemblies. El Segundo, Calif. Naval Strategic Systems Project Office, Washington, D.C. N00030-70-C-0056.

4—**Lockheed Aircraft Corp.**, Burbank, Calif. $10,000,000 (contract modification). Incremental funding for the S-3A weapon system. Naval Air Systems Command, Washington, D.C. N00019-69-C-0385.

—**North American Rockwell Corp.**, Columbus, Ohio. $9,073,477. Incremental funding for Condor missile system engineering development. Naval Air Systems Command, Washington, D.C. NOw 66-0728.

—**United Aircraft Corp.**, Windsor Locks, Conn. $3,081,800 (contract modification). Propeller systems for P-3C aircraft. Naval Air Systems Command, Washington, D.C. N00019-69-C-0607.

—**Philco-Ford Corp.**, Fort Washington, Pa. $1,340,280. Modification kits for sonar equipment. Naval Ship Systems Command, Washington, D.C. N00024-68-C-1132.

—**IBM Corp.**, Oswego, N.Y. $1,290,345. Design of a sonar system. Naval Ship Systems Command, Wasbington, D.C. N00024-70-C-1046.

8—**United Aircraft Corp.**, East Hartford, Conn. $1,876,429. Engine spare parts to support J-57P4A, 10, 16, 20 and 22 engines used on F-8 and A-3 series aircraft. Naval Aviation Supply Office, Philadelphia, Pa. N00383-0-69000A-AG701.

—**Sperry Rand Corp.**, Long Island, N.Y. $1,626,000. Design and development of two pre-production Interface Adapter Units, with spare parts and a computer program. Great Neck, N.Y. Naval Ship Systems Command, Washington, D.C. N00024-69-C-5366.

9—**Johns Hopkins University**, Silver Spring, Md. $3,192,800. Advanced research on surface missile systems. Naval Ordnance Systems Command, Washington, D.C. NOw 62-0604.

—**General Electric Co.**, Washington, D.C. $$2,056,700. Two gas turbine shipboard engines, plus installation and testing. Cincinnati, Ohio. Naval Ship Systems Command, Washington, D.C. N00024-69-C5331.

—**ARINC Research Corp.**, Annapolis, Md. $1,324,431. System effectiveness/cost effectiveness study program of the P-3C avionics system. Naval Air Systems Command, Washington, D.C. N00019-70-C-0027.

10—**Collins Radio Co.**, Cedar Rapids, Iowa. $3,000,000. Submarine emergency communication transmitters. Naval Electronic Systems Command, Washington, D.C. N00039-70-C-1504.

—**American Electronics Inc.**, Fullerton, Calif. $1,142,049. Motor generator sets. Headquarters, Marine Corps, Washington, D.C. M00027-70-C-0022.

11—**American Machine and Foundry Co.**, York, Pa. $1,776,170. Mk 82 Mod 1 bomb bodies. Ships Parts Control Center, Mechanicsburg, Pa. N00104-70-C-A021.

—**Sperry Rand Corp.**, Syosset, N.Y. $1,200,000. Installation, maintenance, modification as necessary, and personnel training services in connection with navigational systems, including Ships Inertial Navigation System, aboard research, oceanographic and special vessels. Naval Regional Procurement Office, Brooklyn, N.Y. N00140-70-C-0202.

12—**General Dynamics Corp.**, Pomona, Calif. $4,281,864 (contract modification). Procurement of Standard ARM missiles for the Navy and Air Force. Naval Air Systems Command, Washington, D.C. N00019-69-C-0336.

—**PRD Electronics, Inc.**, Jericho, N.Y. $11,191,500 (contract modification). Versatile Avionics Shop Test (VAST) stations for F-14A avionics. Naval Air Systems Command, Washington, D.C. N00019-69-C-0334.

—**Raytheon Co.**, Wayland, Mass. $23,109,600. Engineering development of the NATO Sea Sparrow surface missile system. Naval Ordnance Systems Command, Washington, D.C. N00017-70-C-4409.

16—**Sperry Rand Corp.**, Syosset, N.Y. $12,390,056. C-3 Poseidon inertial navigation subsystem equipment for fleet ballistic missile submarines, and training and spare parts. Naval Ship Systems Command, Washington, D.C. N00024-70-C-5007.

—**Western Electric Co.**, New York, N.Y. $1,950,380 (contract modification). Oceanographic research. Whippany, N.J. Naval Electronic Systems Command, Washington, D.C. N00039-69-C-3508.

17—**Ryan Aeronautical Co.**, San Diego, Calif. $12,500,000. BQM-34E aerial target systems. Naval Air Systems Command, Washington, D.C. N00019-69-C-0693.

—**General Dynamics Corp.**, Pomona, Calif. $9,964,690. Standard ARM missiles. Naval Air Systems Command, Washington, D.C. N00019-68-C-0074.

—**Grumman Aerospace Corp.**, Bethpage, N.Y. $2,300,000 (contract modification). Long lead time effort and materials for EA-6B aircraft. Naval Air Systems Command, Washington, D.C. N00019-67-C-0078.

—**Interstate Electronics Corp.**, Anaheim, Calif. $1,761,218. Poseidon missile test and evaluation instrumentation. Naval Strategic Systems Project Office, Washington, D.C. N00030-68-C-0309.

—**RCA**, Moorestown, N.J. $1,695,000. Digital range units for Advanced Range Instrumentation Ships (ARIS) in support of the Pacific Missile Range. Naval Purchasing Office, Los Angeles, Calif. N00123-70-C-0436.

—**Goodyear Tire and Rubber Co.**, Akron, Ohio. $1,410,068. 4,015 fuel cells with baffles for amphibious landing vehicles. Hq., Marine Corps, Washington, D.C. M00150-70-C-0103.

18—**Collins Radio Co.**, Newport Beach, Calif. $10,714,950. VLF radio receivers and transmitters. Naval Electronics Systems Command, Washington, D.C. N00039-70-C-1507.

19—**Grumman Aerospace Corp.**, Bethpage, N.Y. $9,000,000 (contract modification). Long lead time effort and materials for A-6A aircraft production. Naval Air Systems Command, Washington, D.C. NOw 66-0058.

—**Singer-General Precision Inc.**, Little Falls, N.J. $3,870,940. Inertial measurement units and adapter power supplies for A-7E aircraft. Naval Aviation Supply Office, Philadelphia, Pa. N00383-68-A-3201-0174.

—**RCA**, Camden, N.J. $2,663,394 (contract modification). Operation and maintenance of the Atlantic Fleet Range Support Facility for 12 months. Naval Air Systems Command, Washington, D.C. N00019-67-C-0341.

—**General Electric Co.**, Schenectady, N.Y. $53,550,000 (contract modification). Nuclear reactor compartment components. Naval Ship Systems Command, Washington, D.C. N00024-67-C-5321.

—**Hughes Aircraft Co.**, Fullerton, Calif. $2,701,670. Engineering study on passive sonar equipment. Naval Ship Systems Command, Washington, D.C. N00024-70-C-1069.

—**Northrop Corp.**, Norwood, Mass. $1,218,010. Repair of 120 gyroscopes. Naval Ship Systems Command, Washington, D.C. N00024-70-C-5116.

22—The Naval Ships Parts Control Center, Mechanicsburg, Pa., issued the following contracts for bomb bodies, Mk. 82 Mod 1:

American Machine and Foundry Co., York, Pa. $40,072,164. N00104-70-C-A027.

United States Steel Corp., Pittsburgh, Pa. $39,637,188. McKeesport, Pa. N00104-70-C-A032.

American Manufacturing Co. of Texas, Fort Worth, Tex. $39,555,630. N00104-70-C-A028.

Norris Industries, Los Angeles, Calif. $34,598,400. N00104-70-C-A031.

—**American Electric Inc.**, La Mirada, Calif $1,499,425. Mk 87 Mod 1 practice bombs Naval Ships Parts Control Center, Mecbanicsburg, Pa. N00104-70-C-A009.

—**Honeywell, Inc.**, Hopkins, Minn. $1,916,716. Lots 1-13 of Mk 46 Mod 1 torpedoes. Naval Ordnance Systems Command, Washington, D.C. N00017-67-C-1102.

—**United Aircraft Corp.**, East Hartford, Conn. $2,520,033. TF-30P6/P8 engine spare parts for A7A/B aircraft. Naval Aviation Supply Office, Pbiladelphia, Pa. N00383-0-69000A-AG729.

23—**General Dynamics Corp.**, Pomona, Calif $24,008,312. Standard ARM missiles Naval Ordnance Systems Command, Washington, D.C. N00017-67-C-2107.

—**Akwa-Downey Construction Co.**, Milwaukee, Wis. $4,855,771. Construction of a VLF antenna and grounding system, Naval Radio Station, Lualualei, Hawaii. Naval Facilities Engineering Command, Washington, D.C. N62471-69-C-0314.

—**The Johns Hopkins University**, Silver Spring, Md. $2,935,100. Increased level of effort for advanced research on surface missile system. Naval Ordnance Systems Command, Washington, D.C. NOw-62-0604-c.

24—**United Aircraft Corp.**, East Hartford, Conn. $5,526,327 (contract modification). J-52-P-8A engines. Naval Air Systems Command, Washington, D.C. N00019-67-C-0182.

—**Lockheed Aircraft Corp.**, Marietta, Ga. $5,148,048. Services and materials necessary for progressive rework on C-130 series aircraft. Naval Air Systems Command, Washington, D.C. N00019-70-C-0153.

—**Bendix Corp.**, Baltimore, Md. $2,219,310. Receiver transmitters and associated equipment for the Navy and Air Force. Naval Air Systems Command, Washington, D.C. NOw 66-0637.

—**Yardney Electric Corp.**, New York, N.Y. $2,619,000. Production of Mk 46 Mod 1 batteries. Pawcatuck, Conn. Naval Ordnance Systems Command, Washington, D.C. N00017-70-C-1404.

—**Bendix Corp.**, Teterboro, N.J. $1,215,000. Programmed adaptors for use with the AN/GSM-133 automatic test set used on F-4 series aircraft missile control, navigation, identification and communication systems. Naval Purchasing Office, Los Angeles, Calif. N00123-70-C-0510.

25—**Grumman Aerospace Corp.**, Bethpage, N.Y. $8,600,000 (contract modification). Incremental funding for E-2C aircraft. Naval Air Systems Command, Washington, D.C. N00019–68–C–0542.

—**General Signal Corp.**, Woodbury, N.Y. $1,702,350. Radar equipment. Naval Air Systems Command, Washington, D.C. N00019–70–C–0111.

—**North American Rockwell Corp.**, Anaheim, Calif. $1,350,000. Modification, improved calibration techniques and design of Ships Inertial Navigation Systems. Naval Ship Systems Command, Washington, D.C. N00024–70–C–5156.

26—**Curtiss-Wright Corp.**, Wood-Ridge, N.J. $4,589,480. Modification kits for conversion of J–65–W–16A engines to -20 configuration. Naval Aviation Supply Office, Philadelphia, Pa. F41608–69–A–0057.

29—**Curtiss-Wright Corp.**, Wood-Ridge, N.J. $1,788,308. Modification kits for J-65 engines used in A-4 series aircraft. Naval Aviation Supply Office, Philadelphia, Pa. F41608–69–A–0057.

—**EFMC Corp.**, Compton, Calif. $1,084,512. Mk 19 Mod 1 plastic windshields for 3-inch 50 caliber twin gun mounts. Naval Ordnance Station, Louisville, Ky. N00197–70–C–0156.

—The Naval Air Systems Command, Washington, D.C., issued the following contracts:

Sperry Rand Corp., St. Paul, Minn. $6,155,325. CP-901/ASQ-114 computers. N00019–70–C–0110.

Beech Aircraft Corp., Wichita, Kan. $5,994,558. AQM–37A missile targets. Boulder, Colo. N00019–70–C–0142.

Sundstrand Corp., Rockford, Ill. $3,105,804 (contract modification). Constant speed drives for F-4E, RF-4E and F-4J aircraft. N00019–68–C–0083.

Garrett Corp., Phoenix, Ariz. $1,474,200. T76–G–410–411 turboprop engines and containers. N00019–70–C–0063.

30—**Intercontinental Manufacturing Co.**, Garland, Tex. $16,444,840. Mk 82 Mod 1 500-pound bomb bodies. Naval Ships Parts Control Center, Mechanicsburg, Pa. N00104–70–C–A030.

—**Borg-Warner Corp.**, Chicago, Ill. $15,586,028. Mk 82 Mod bomb bodies. Naval Ships Parts Control Center, Mechanicsburg, Pa. N00104–70–C–A029.

—**General Motors Corp.**, Indianapolis, Ind. $3,437,100. Provisioning kits for T56 engines. Naval Aviation Supply Office, Philadelphia, Pa. F34601–69–A–2021.

DEPARTMENT OF THE AIR FORCE

2—**General Electric Co.**, Cincinnati, Ohio. $1,500,000. Engineering effort and services to improve components of the TF-39 aircraft engine. Evandale, Ohio. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–67–C–1221.

3—**Northrop Corp.**, Hawthorne, Calif. $8,684,640. T–38A aircraft, spare parts and aerospace ground equipment. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–70–C–0216.

—**The Boeing Co.**, Seattle, Wash. $3,761,710. Production of electronic test equipment for Minuteman III weapon system. Ogden Air Materiel Area, AFLC, Hill AFB, Utah. F04606–69–A–0171–QP61.

—**Lockheed Aircraft Services, Inc.**, Jamaica, N.Y. $3,700,000. Modification and maintenance of special air mission aircraft. Oklahoma Air Materiel Area, AFLC, Tinker AFB, Okla. F34601–70–C–0240.

4—**The Boeing Co.**, Seattle, Wash. $2,570,387. Design, development and test of Minuteman III weapon system additives. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. AF04(694)–791.

5—**General Electric Co.**, Philadelphia, Pa. $6,000,000. Low angle re-entry flight test program. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. F04701–69–C–0157.

—**Cessna Aircraft Co.**, Wichita, Kan. $3,000,000. A–37B aircraft, spare parts and aerospace ground equipment. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–70–C–0018.

—**Lockheed Aircraft Corp.**, Marietta, Ga. $1,218,480. Spare parts for C-5A aircraft. Detachment 31, San Antonio Air Materiel Area, AFLC, Marietta, Ga. AF33(657) 15053.

—**Dynamics Corp. of America**, Bridgeport, Conn. $5,014,118. Production of diesel generator sets, MB–15, –16, –17, –18, and –19. Sacramento Air Materiel Area, AFLC, McClellan AFB, Calif. F04606–68–D–0575.

8—**The Boeing Co.**, Seattle, Wash. $19,819,000. Procurement of Minuteman missiles. Seattle and Clearfield, Utah. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. F04701–68–C–0165.

—**General Electric Co.**, Cincinnati, Ohio. $1,020,000. Procurement of T–64 engine mobile test stands. Evandale, Ohio. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–68–C–0737.

10—**Cessna Aircraft Co.**, Wichita, Kan. $2,695,000. Modification of T-37B aircraft. San Antonio Air Materiel Area, AFLC, Kelly AFB, Tex. F41608–70–C–0555.

—**IBM**, Gaithersburg, Md. $2,124,000. Design of airborne and ground electronics equipment. Electronic Systems Division, AFSC, L. G. Hanscom Field, Mass. F19628–69–C–0046.

—**Texas Instruments, Inc.**, Dallas, Tex. $2,504,619. Production of airborne radar equipment for RF-4 aircraft. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–69–C–0251.

—**Lockheed Aircraft Corp.**, Marietta, Ga. $1,379,221. Aerospace ground equipment for C–5A aircraft. Aeronautical Systems Division, AFSC, Wright-Patterson, AFB, AF33(567)–15053.

11—**ITT Research Institute**, Chicago, Ill. $4,680,200. Operation of an electromagnetic compatibility analysis center. Annapolis, Md. Electronics Systems Division, AFSC, L. G. Hanscom Field, Mass. F19628–69–C–0073.

—**United Aircraft Corp.**, East Hartford, Conn. $1,820,000. Conversion of TF–30–P–12A engines to TF–30–P–7 configuration. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. N383–69000A.

12—**General Dynamics Corp.**, San Diego, Calif. $2,151,002. Models 3A and 3C standard launch vehicles (Atlas boosters). Space and Missiles Systems Organization, AFSC, Los Angeles, Calif. F04701–69–C–0001.

—**TRW Systems Group**, TRW, Inc., Redondo Beach, Calif. $1,006,020. Technical services for Minuteman II and III propulsion systems. Norton AFB, Calif. Space and Missile Systems Organization, Los Angeles, Calif. F04701–70–C–0101.

—**Bendix Corp.**, Teterboro, N.J. $1,125,558. Navigational computer system components (AN/ASN-46A) for F–4 aircraft. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–70–C–0329.

15—**General Electric Co.**, West Lynn, Mass. $2,180,000. Spare parts for J–85 aircraft engines. San Antonio Air Materiel Area, AFLC, Kelly AFB, Tex. F34601–69–D–2254.

—**General Electric Co.**, Cincinnati, Ohio. $3,700,000. J-79 aircraft engine components. Oklahoma City Air Materiel Area, AFLC, Tinker AFB, Okla. F34601–69–A–1029.

—**The Boeing Co.**, Seattle, Wash. $1,243,000. Removal and replacement of modified Minuteman missiles. Malmstrom AFB, Mont., Whiteman AFB, Mo., and Grand Forks AFB, N.D. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. F04701–69–C–0232.

—**Lear Siegler, Inc.**, Santa Monica, Calif. $4,039,699. A/A37G-3 flight control systems components for BQM–34 and MQM–34 target missiles. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–69–C–0340.

—**International Telephone and Telegraph Corp.**, Nutley, N.J. $1,198,387. Organization and field level maintenance, and training services in support of the Strategic Air Command Automated Control System. Omaha, Neb., Bossier City, La., Riverside, Calif., Chicopee Falls, Mass., and Nutley. Oklahoma City Air Materiel Area, AFLC, Tinker AFB, Okla. F34601–70–C–0526.

17—**Litton Systems, Inc.**, Woodland Hills, Calif. $9,645,975. Repair of gyroscopes for the F-4 aircraft. Oklahoma City Air Materiel Area, AFLC, Tinker AFB, Okla. F04606–69–A–0203 SD39.

—**Thiokol Chemical Corp.**, Brigham City, Utah. $10,200,000. Production of stage 1 motors for Minuteman III missiles. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. F04701–69–C–0197.

18—**Sargent-Fletcher Co.**, El Monte, Calif. $3,827,656. Fuel tank assemblies for F/RF-4 series aircraft. Ogden Air Materiel Area. AFLC, Hill AFB, Utah. F042600–69–D–0226–0001.

—**Lockheed Aircraft Corp.**, Marietta, Ga. $1,699,011. Spare parts for C-5A aircraft. Detachment 31, San Antonio Air Materiel Area, AFLC, Marietta, Ga. AF33(657)15053.

—**Singer-General Precision, Inc.**, Binghamton, N.Y. $1,655,592. Design, develop, fabricate, test and install A/F37A–T–40 trainer, spare parts and aerospace ground equipment. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–70–C–0013.

—**Westinghouse Electric Corp.**, Baltimore, Md. $3,500,000. Production and test of four Air Traffic Control Sets (AN/GPS-6), spare parts and support data. Electronic Systems Division, AFSC, L.G. Hanscom Field, Mass. F19628–70–C–0049.

22—**Space Corp.**, Garland, Tex. $8,042,550. Turbo-prop and turbojet engine test stands. San Antonio Air Materiel Area, AFLC, Kelly AFB, Tex. F41608–70–C–5472.

—**Goodyear Aerospace Corp.**, Akron, Ohio. $1,000,000. Mobile armament recording camera. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–70–C–0297.

—**General Dynamics Corp.**, Fort Worth, Tex. $3,547,800. Production of F–111 aircraft. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. AF33(657)-13403.

23—**Texas Instruments, Inc.**, Dallas, Tex. $2,390,000. Components for airborne infrared detecting equipment. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–70–C–0285.

24—**General Dynamics Corp.**, Fort Worth, Tex. $31,942,483. Supplemental agreement for production of F–111 aircraft. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. AF33(657)13403.

—**The Boeing Co.**, Seattle, Wash. $18,790,189. Force modernization of Minuteman Wing III. Minot, N.D. Space and Missile Systems Organization, Los Angeles, Calif. F04701–68–C–0042.

25—**General Electric Co.**, West Lynn, Mass. $1,927,400. Production of J-85 and T-58 engines. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–69–C–0005.

—**REDM Corp.**, Wayne, N.J. $1,223,738. Component parts for general purpose bombs. Ogden Air Materiel Area, AFLC, Hill AFB, Utah. F42600–70–C–0439.

—**J. A. Maurer, Inc.**, Long Island City, N.Y. $1,278,241. Cameras and component parts for RF-5 aircraft. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657–69–C–0875.

26—**McDonnell Douglas Corp.**, Tulsa, Okla. $1,770,964. Modification and maintenance of B-52 aircraft. Oklahoma City Air Materiel Area, AFLC, Tinker, Okla. F34601–69–C–0009.

29—**Lockheed Aircraft Service Co.**, Midwest City, Okla. $1,206,000. Repair and modification of F-84 series aircraft. Oklahoma City Air Materiel Area, AFLC, Tinker AFB, Okla. F34601–69–C–4414–0004 AA.

—**Dynalectron Corp.**, Fort Worth, Tex. $1,725,000. Corrosion control for various aircraft. Kadena AB, Okinawa. Oklahoma City Air Materiel Area, AFLC, Tinker AFB, Okla. F3460–69–D–4415

—**North American Rockwell Corp.**, Anaheim, Calif. $71,472,280. Minuteman III guidance and control systems. Space and Missile Organization, AFSC, Los Angeles, Calif. F04701–68–C–0174.

30—**Emerson Electric Co.**, St. Louis, Mo. $5,107,000. Electronic test equipment for C–141. RF-4C and F-111 aircraft avionic systems. San Antonio Air Materiel Area, AFLC, Kelly AFB, Tex. F41608–70–C–6020.

—**North American Rockwell Corp.**, Anaheim, Calif. $14,308,300. Design and fabrication of depot maintenance ground equipment and factory tooling and test equipment in support of Minuteman III guidance and control systems. Space and Missile Systems Command, AFSC, Los Angeles, Calif. F04701–69–C–0129.

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DCS-Mallard Interface Task of Study Group

Analysis of the interface between the Defense Communications System (DCS) and tactical communications systems using equipment developed by Project Mallard is the task of a working group established by the Defense Communications Agency (DCA).

The new DCA-Mallard Interface Technical Working Group (ITWG) will identify problems, develop alternative solutions, and make recommendations to the Director of DCA and the U. S. Manager of the Mallard Project. Overall objective of the ITWG is to assure a cost-effective interface between DCS and tactical communications systems using Mallard-developed equipment.

Project Mallard was initiated in 1965 as an international cooperative program to develop a secure digitally switched tactical communications system common to the four member nations, the United States, Australia, Canada and the United Kingdom.

DCA is responsible for management control and direction of the worldwide DCS, operated by the three Military Services.

Air Force Begins Field Tests of Air Mobile Bases

In Air Force logistics, mobility means moving an entire air base, from runway lights to barracks, in a hurry. And to the Aeronautical Systems Division (ASD), AFSC, Wright-Patterson AFB, Ohio, that means a system of lightweight and durable air transportable equipment that can be ready for use hours after reaching a new base site.

ASD's Air Mobility Program Office, headed by Lieutenant Colonel Donald D. Klein, has the responsibility for assembling and testing the 2,700 items in the "bare base" concept. The first phase of field tests to demonstrate this concept are scheduled to begin this fall.

Equipment developed and procured for the tests include:

- Expandable shelters to serve as maintenance shops, kitchens or sanitary facilities. The units are constructed of aluminum frames, with polyurethane foam-filled siding.
- Aircraft hangars, each capable of housing an F–4, and requiring 160 man-hours to erect.
- Personnel shelters for 11 to 20 individuals.
- Airfield lighting, including approach, runway and taxiway lights, glide angle indicator and beacon.
- An electrical distribution system providing complete electrical power for a bare base of nearly 600 shelters. With a 4,160 volt primary system, it is stepped down to 60 cycle, 110-208 volt power for the user.
- A gas turbine powered liquid oxygen and nitrogen generator, with a capacity of two tons per day.
- Two heating systems, a 60,000 BTU per hour system for living and working spaces, and a 400,000 BTU per hour system for hangars and large working spaces.
- Kitchens, with a 250 meal per hour capacity, a water distribution system and sanitary facilities.
- Tow trailers for the logistic shelter air transportables (LSATs) and personnel shelters, compatible with the rail cargo handling systems on the C–130 and C–141 aircraft, and designed for use from aircraft to base site.

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